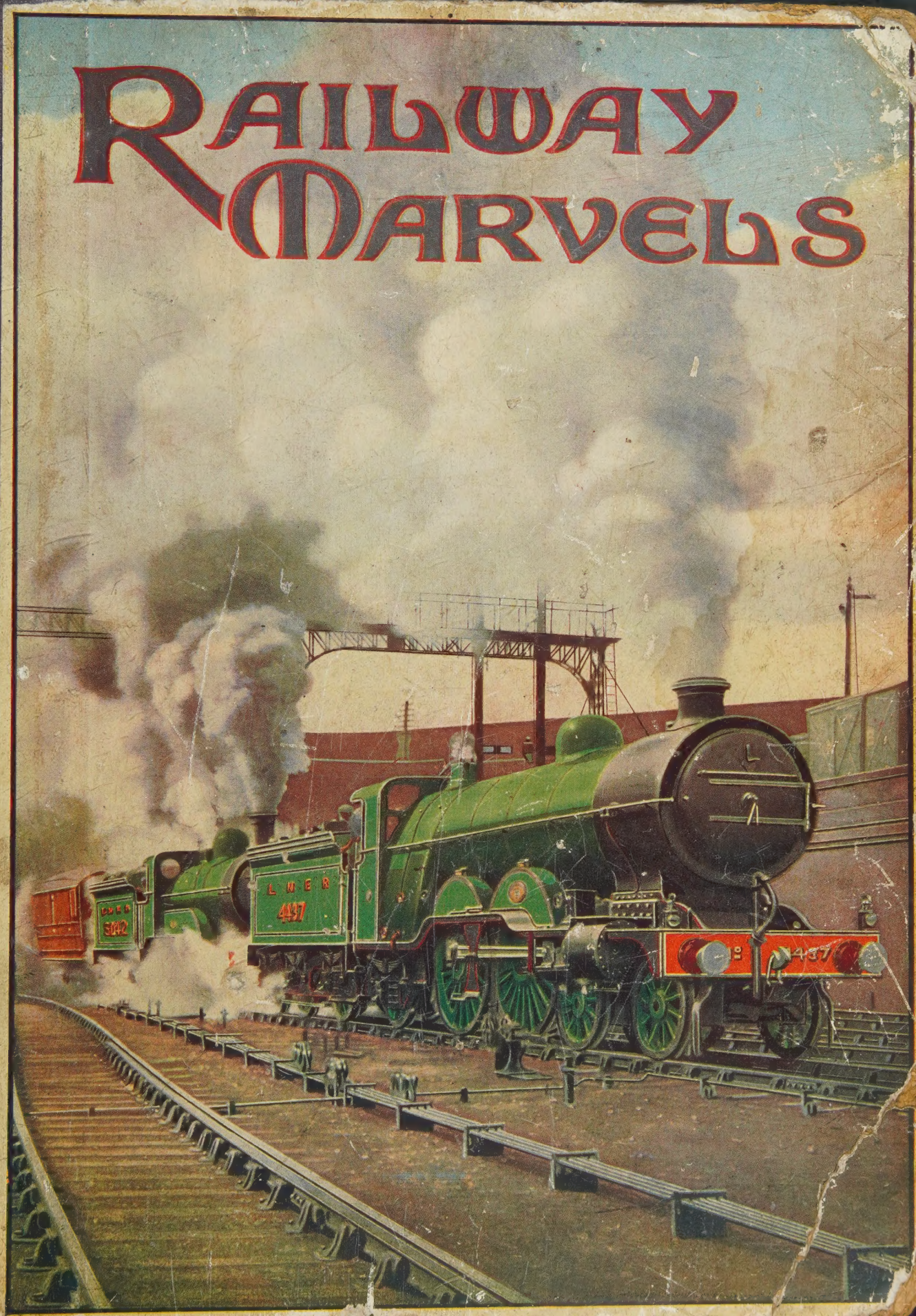
RAILWAY MARVELS



To Leslie
from Aunt Kate, Nellie & Lillie

Xmas 1926.

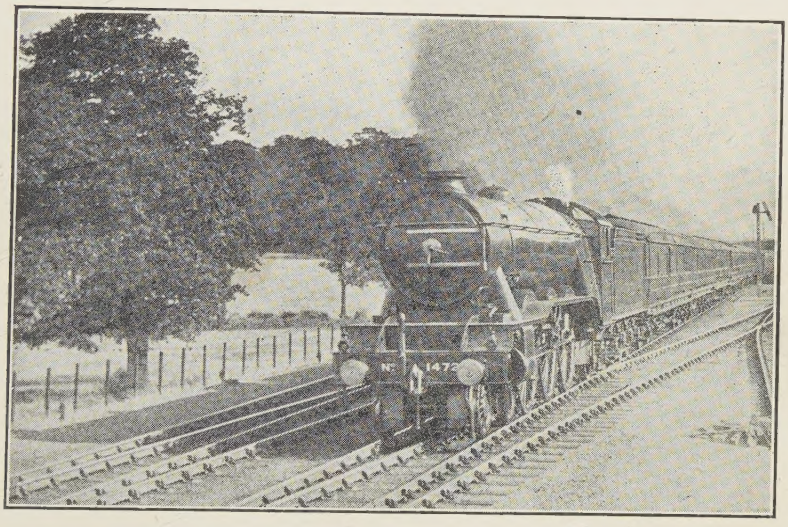
A Heavy Express Train Leaving King's Cross, L.N.E.R.

RAILWAY MARVELS

THE WONDERFUL RAILWAY ENGINEERING PROGRESS OF ONE HUNDRED YEARS, ILLUSTRATED AND DESCRIBED FOR CHILDREN

BY

CECIL J. ALLEN, A.M.Inst.T.



The "Flying Scotsman"

LONDON
JOHN F. SHAW & CO., LTD.
3 PILGRIM STREET, E.C. 4

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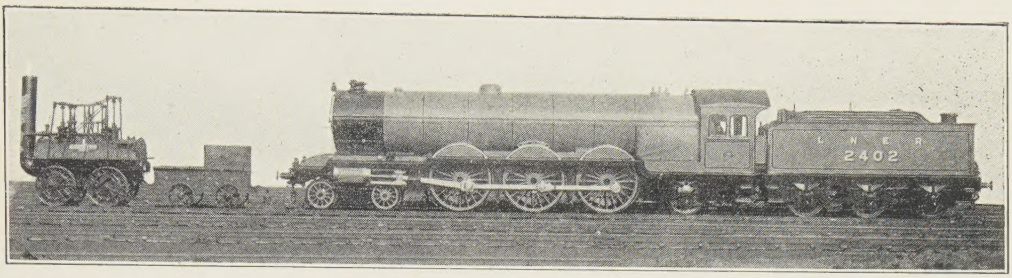


1825–1925: A Striking London and North Eastern Railway Comparison

ONE HUNDRED YEARS OF RAILWAY TRAVEL

IT was on 27th September, 1825, that the first railway was opened to carry passengers. It ran between the towns of Stockton and Darlington, away up in the county of Durham. On the left-hand of the picture above you see the very first engine that ever worked a passenger train, not only in this country, but in the world.

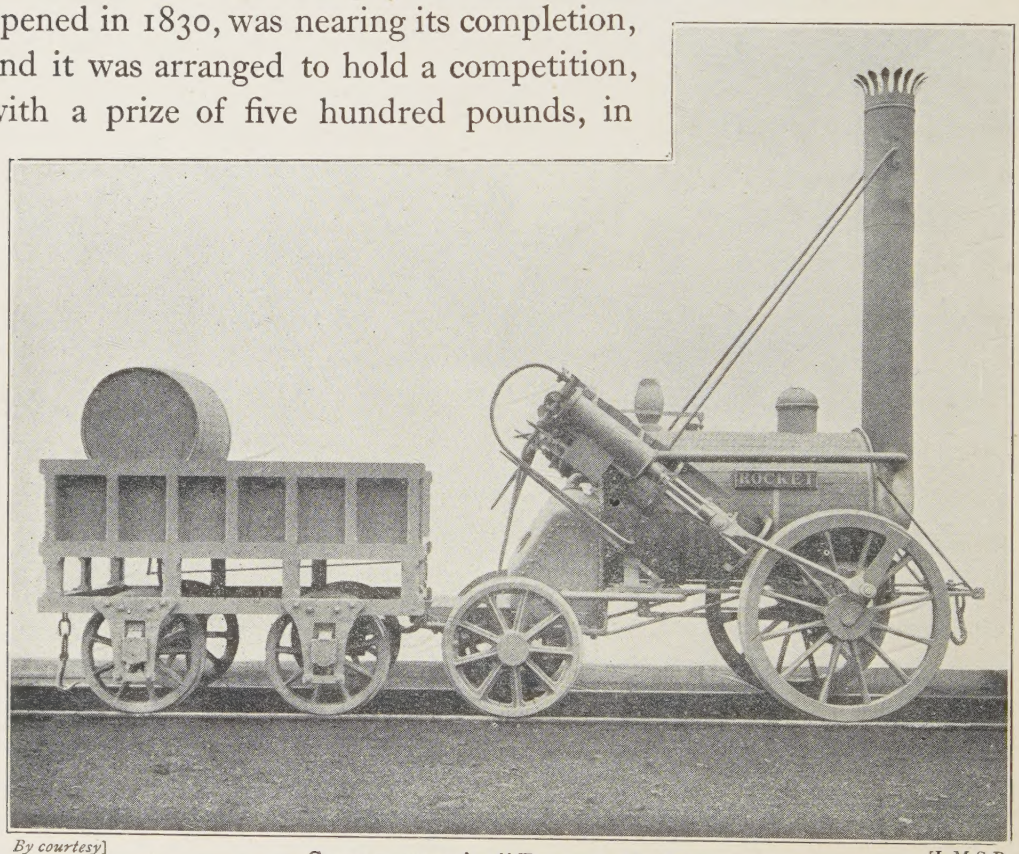
For many years this little engine, "Locomotion"—No. 1 of the Stockton and Darlington Railway—has been preserved on a pedestal at Darlington Station; and in 1924 it was put once again on the rails and bravely made the journey of two-hundred-odd miles from Darlington to the great British Empire Exhibition at Wembley. There, no doubt, many of you saw it—standing alongside one of the latest and most powerful London and North Eastern locomotives, "The Flying Scotsman."

You have a similar contrast in the photograph at the head of this chapter, which shows another modern London and North Eastern "Pacific" engine, actually built at Darlington, end-to-end with little "Locomotion." Nothing could bring home to us in a more remarkable way the development of a hundred years in railway travel, than the difference between the 11-ton engine of 1825 and the 150-ton locomotive of 1925. "Locomotion" could travel at from

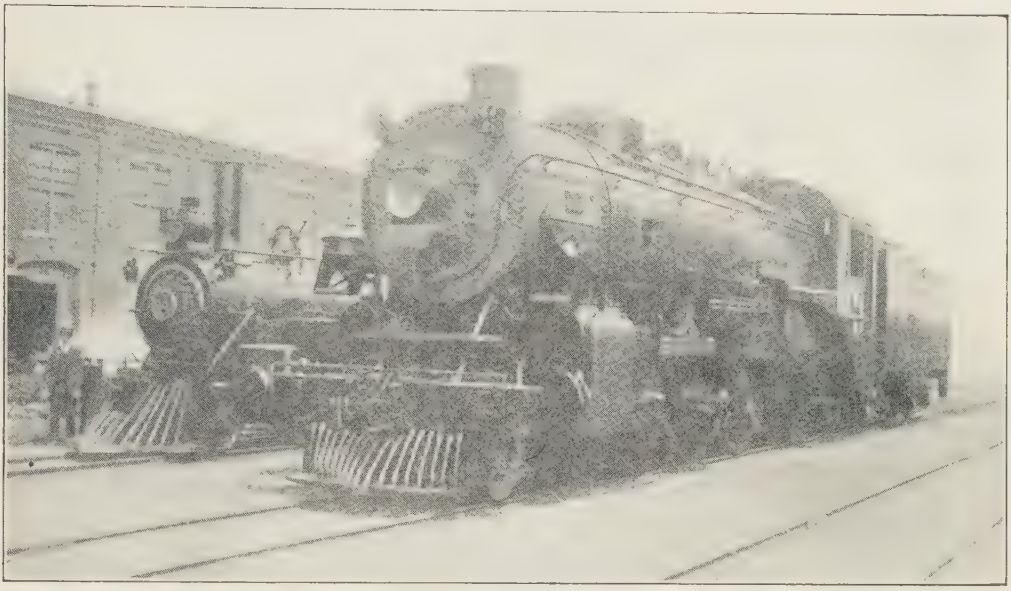
six to eight miles an hour, whereas the great " City of York " is good for seventy-five miles an hour and more.

" Locomotion " was not, however, the first steam engine. Murdoch, in 1784, designed a steam locomotive to run on the high roads. One dark night, when he was trying his invention along a secluded lane near Redruth, in Cornwall, where he was working, he so frightened the worthy vicar of the parish—whom he met on the way—that the vicar thought he must be face-to-face with the Evil One himself !

Then, in the year 1803, a man named Trevethick designed and built, in South Wales, the first locomotive engine to run on rails. But perhaps the most famous of the early engines was Stephenson's " Rocket." The Liverpool and Manchester Railway, which was opened in 1830, was nearing its completion, and it was arranged to hold a competition, with a prize of five hundred pounds, in



By courtesy] STEPHENSON'S " ROCKET," 1829 [L.M.S.R.



PAST AND PRESENT ON THE CANADIAN PACIFIC RAILWAY

order to decide what would be the best type of engine to use on the railway.

It was the " Rocket " that proved the victor. To the credit of this far-seeing engineer be it said that some of the features of design that he included in his engine of long ago are still standard in our engines of nearly a hundred years later. All the tests were complied with, and the " Rocket " attained a speed of twenty-nine miles an hour—a much higher speed than had ever previously been run.

The vast importance of railways, which in their earliest days had been bitterly opposed, very soon began to be realised on all hands. New railways were planned in all directions. By the year 1838 the mails had been transferred from the mail-coaches to the trains. Eight years later people had become so tremendously in favour of travel by railway that, in the year 1846, no less than 272 different "Acts " were passed by the Houses of Parliament to sanction the building of railways in different parts of this country.

One by one the bigger railways have swallowed up the smaller ; and in the year 1923 there came into force what is known as the

" grouping " of the railways. By this Act of Parliament all the many railways of Great Britain, except just the London Underground railways, have been swallowed up into four vast groups. Up the western side of England and Scotland there lies the network of the biggest group—the London, Midland and Scottish—and up the eastern side that of the London and North Eastern Railway ; the Great Western Railway stretches its wide-spreading arms all over the West Country, and the Southern Railway occupies the south.

The hundred years of railway development has produced no less than 24,400 miles of railway in the British Isles. If these railways were stretched out end-to-end they would all but girdle the world. To-day it would be impossible to do without them. Just as the veins and arteries in the human body carry the blood which is the basis of life, so the railways are to the country like the veins and arteries which carry the raw materials and the finished products of the industries that are the basis of our national life.

The last two pictures in this chapter emphasise, in a most striking

Photo] A Present-day Pullman Car Express on the L.N.E.R. [F.E. Mackay

By courtesy] [L.N.E.R.

"LOCOMOTION" AND HER TRAIN AT STOCKTON STATION IN THE GREAT RAILWAY CENTENARY PROCESSION OF 1925

way, the progress of railway travel in the course of a century. Opposite you see a palatial present-day Pullman car express, running two hundred miles without a stop. Above is seen "Locomotion," once again on the rails, hauling her train of 1825 over the track of 1925, in the great procession of engines and trains from Stockton to Darlington, with which the Railway Centenary was celebrated. The only thing I ought not to tell you is that "Locomotion" was actually driven, for the occasion, by means of a petrol motor cunningly concealed in her tender! In the procession between fifty and sixty locomotives, of all types and ages from "Locomotion" to the latest giants of to-day, took part, and those of us who were privileged to witness that wonderful "show" are never likely to forget it. Amazing indeed has been the development of the railway—practically unknown a century ago, and now spread over the wide world to a total length of three-quarters of a million miles.

Photo] [F. E. Mackay

TAKING WATER FROM IPSWICH WATER-TROUGHS, L.N.E.R.

PICKING UP WATER AT FULL SPEED

LOCOMOTIVE engines are terribly thirsty monsters. On such a run as that of the wonderful Great Western "Cornish Riviera" express—which flies every day over the two hundred and twenty-six miles from Paddington terminus in London to Plymouth without stopping anywhere on the way—the engine will swallow quite easily over thirty tons of water.

Now, how is so tremendous a quantity as this to be stowed away ready for use? It would need three or four ordinary engine tenders to hold as much, for the big water-tank in the tender of a Great Western express engine can only find room for about three thousand five hundred gallons all told.

Many years ago, a well-known locomotive engineer named Ramsbottom foresaw that in days to come we should want to travel long distances without stopping, and that this question of water would

be a difficulty. So he thought out a clever arrangement by which an engine could scoop up fresh supplies while running at full speed.

What he did was to find a perfectly level stretch of line, and there to lay down between the rails a shallow trough, rather over a quarter of a mile long, filling it with water. Probably all of you have seen, at some time or other, those long shining ribbons of water in the centre of the railway track; the nearest to London, for example, may be found at Bushey, near Watford, on the North Western main line, and at Ruislip, on the Great Western main line to Birmingham.

As the express nears the beginning of the trough, the fireman lowers, by suitable machinery, a hinged scoop under the tender, in the shape of a bucket. By a very slight downhill gradient in the track the scoop is then lowered into the trough, and the speed at which the train is travelling forces the water, at very great pressure, up out of the trough through a big vertical pipe into the tender tank.

Most water is not picked up at the highest speeds, as you might think; when the train is travelling very fast, as in this picture of a

Photo] [F. E. Mackay

BIRMINGHAM EXPRESS TAKING WATER AT 80 MILES AN HOUR, G.W.R.

Great Western Birmingham two-hour express—which was probably doing round about eighty miles an hour—a lot of water is scattered at the point of the scoop, and makes the big " splash " that you see.

As soon as the tender tank is full, which the fireman can see by means of a gauge on the footplate, he lifts the scoop out of the water ; in the space of ten or fifteen seconds anything from a thousand to fifteen hundred gallons may have been picked up. On the journey to Plymouth, to which I have referred, it is possible to pick up water four times ; if you are travelling by the West Coast route to Scotland, there are no less than nine sets of troughs between Euston and Carlisle.

The advantage of the troughs is not only that of saving the weight of enormous tenders or saving time in stopping to take water. Locomotives are very particular about what they drink. What is called " hard " water causes deposits to form all over the parts of the boiler where steam is being produced, and makes an engine steam badly. But the laying down of water-troughs just where the water is of best quality, as well as cheap and plentiful, enables the engines to take as much as they need, without having to stop for the purpose.

Photo] [F. E. Mackay

PICKING UP WATER ON THE L.M.S., NEAR MANCHESTER

PETROL-ELECTRIC PASSENGER COACH, CANADIAN NATIONAL RAILWAYS

MOTOR-CARS ON RAILS

WORKING branch lines is a problem to the railways nowadays. It is an expensive business to keep an engine in steam all day just to work one or two trains to and fro, eating up coal all the time, although it may be doing very little work. So the attention of railway engineers is turning to other kinds of motive power.

Here is a remarkable car recently introduced on the vast system of the Canadian National Railways. Two-thirds of its length is used to seat passengers ; in the remainder is housed a petrol motor driving a dynamo, which makes the electricity employed to drive the coach. In an experimental trip right across Canada, the engine of the car was never stopped for a total time of 67 hours, during which the car travelled no less than 2937 miles.

Our own country is not behind in these developments. Round about York the London and North Eastern Railway has more than one motor-bus running on rails. The one seen in this illustration

[L.N.L.R.

A "Ford" Car on the Railway

is actually a familiar "Ford" car, adapted in this way to run on rails, and looks strangely out of its element!

For many years past steam motor-coaches have been used in this country, especially on the G.W.R., and the success of a new design, called the "Sentinel-Cammell" car, makes it probable that we shall see many more such cars used for branch line working.

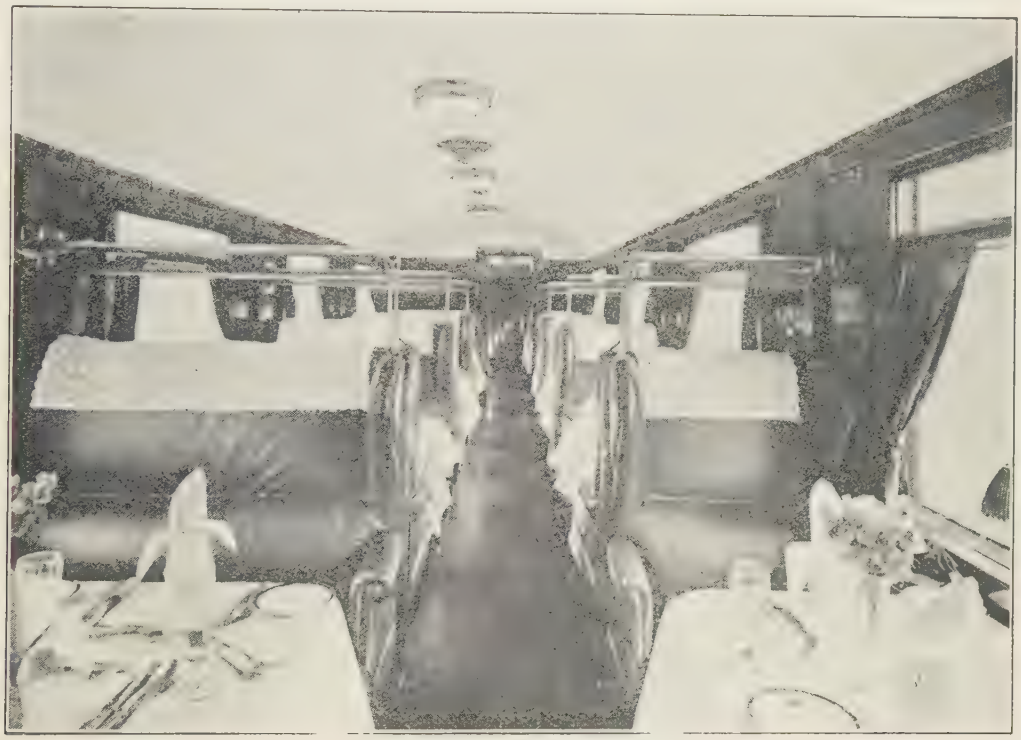
MEALS ON WHEELS

HOW very different travelling would be to-day without our dining cars! Many of you very likely see the inside of a dining car only when you are going on long holiday journeys, and so perhaps you look upon it as rather a rarity. But you would be astonished to hear that in the summer-time, when the number of people on holidays bent makes it necessary to run more long-distance express trains than at any other time in the year, nearly seven hundred trains run in this country every day with restaurant cars attached to them. So you need never go hungry on the railway!

Not all the restaurant cars are the big coaches shown in these pictures. Sometimes, on trains which travel in the afternoons, when only teas and light refreshments are needed, a dining car is not provided. But an ordinary corridor coach is taken, and in one or two of its compartments, instead of seats for passengers, there are fitted up a tiny kitchen and pantry, with arrangements for boiling

water to make tea, and for washing up, as well as storage space for crockery and eatables. The " teas " are then prepared on trays, and the attendants carry them to passengers in the train, just where they sit.

But such an arrangement would never do where there are meals to be served, and cooking has to be done. Cooking on a large scale requires a great deal more room, and very careful planning and



First-Class Dining Car on the "Flying Scotsman," L.N.E.R.

equipment of the kitchen, or the work could never be got through in the limited time available. Indeed, some of the latest dining car " sets " on the London and North Eastern and London, Midland and Scottish Railways have separate " kitchen cars "—coaches given up entirely to kitchen, pantry and accommodation for the restaurant car staff.

At busy times the work in the restaurant car is really hard. Some-

New Kitchen Car, London, Midland and Scottish Railway

times, and more especially at lunch, seventy or eighty people will sit down at once, and when you think that each one is going to be served with soup, then fish, then joint, then sweets and then cheese, you will get some idea of the number of knives, forks, spoons, plates and glasses to be washed up, let alone the serving of the food ! Remember all the time the limited size of the kitchen and pantry, as you can see in these pictures, and you will understand the difficulties.

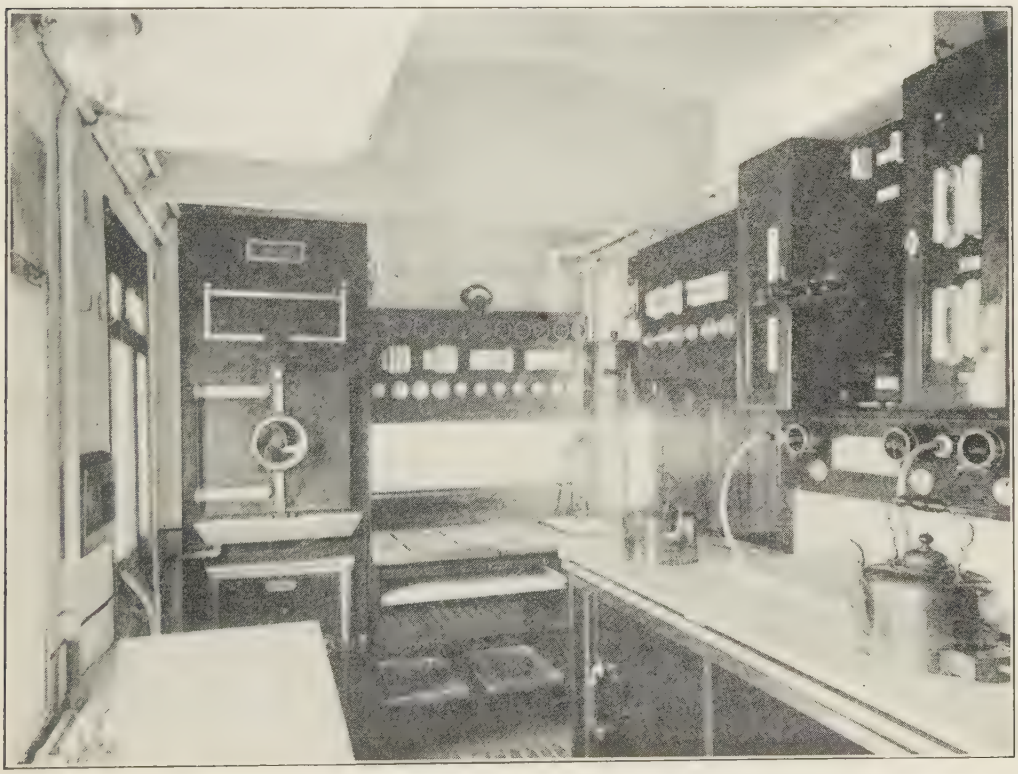
And then it is not as though one meal only were served. On long-distance trains like the East and West Coast Scotch expresses, or the Cornish trains of the Great Western Railway, there will generally be three " sittings " to accommodate all the people who want to take lunch, and sometimes even four, one after another. All the work of serving each " relay " of people, of collecting the bills, and then of washing up and laying the tables again, has often to be got through in less than an hour. On other trains, again, as soon as lunch is disposed of, the service of teas must begin ; and teas, again, have to give place to dinner, for all of which much preparation is necessary.

When the train is starting from a terminal station shortly before

a meal is going to be served, it is frequently the practice to put the joints on board already cooked, or partly cooked, from a kitchen on the station premises. Pastry, too, and soup is usually handed on to the trains ready-made. But on other trains every scrap of cooking is actually done on the train itself.

In the very first dining car on record, which ran on the Great Northern Railway between London and Leeds in 1879, the cooking was carried out in the oven of an ordinary kitchen range ; this was long before the days of electricity or gas on the trains. The people who wanted to dine had to take their seats in the car, for there were no corridors, either ; and the catering was done by a gentleman who owned a restaurant in Leeds.

To-day it is chiefly gas that is used for cooking purposes. But



Electric Kitchen on the L.N.E.R. "Flying Scotsman"

on the very latest restaurant cars of the London and North Eastern Railway, the cooking is carried on by electricity. You can see, in the picture of the inside of the kitchen on the new " Flying Scotsman," how the *chef* has electrical cooking appliances all round him. He appreciates the electric cooking immensely ; it is so much cooler in the kitchen than with gas, and it is better for the food, too.

The electricity for cooking, just like that which lights the compartments, is made by the train itself while running. Underneath the coaches you may see the dynamos generating electricity ; they are driven by belts off the axles of the wheels. Electricity is stored for use in large accumulators, also carried under the coaches, like the accumulators you use for your wireless set, only on a much larger scale.

An Indian Dining Car, Great Indian Peninsula Railway

INDIAN RESTAURANT CAR

In this country the dining cars usually travel through with the train from the beginning to the end of its journey, and passengers who want to take meals are allowed, if they desire, to sit all the time in the cars instead of in an ordinary compartment. But on the Continent, or in America, where the journeys are of tremendous length, day and night continuously, the cars are often attached to the train just at breakfast-time, or lunch-time, or dinner-time, for the meal to be served, and then taken off again. This saves hauling a heavy restaurant car along during the night-time, when it is not needed.

So the restaurant car business has grown to an enormous extent in the brief space of forty-five years. In fact, with the working also of refreshment rooms and hotels, the business of catering is one of the most important of railway activities to-day.

A CURIOUS LOCOMOTIVE

THE engine illustrated on the next page is not only a strange-looking creature, but it runs on a little-known railway. At a place called Beckton, on the east side of London, is found the vast works of the Gas Light and Coke Company, which makes gas for nearly all that part of the great Metropolis north of the River Thames.

Although the works only covers some 270 acres of ground, yet

into this small area there are crowded over forty miles of railway. Gas is made by " baking " coal in what are called " retorts," and what is left of the coal is known as coke. The coal for the gas-making, which arrives both by water, up the Thames, and also by rail, has to be taken into the various " retort-houses," and then the coke is withdrawn from the retorts, when the operation is complete, and taken away by rail or sea wherever required.

It was specially in order that this engine might be able to go through the doorways into the retort-houses that it was designed in so curious a fashion. Instead of the thirteen feet or so in height available on an ordinary railway, it had to be cut down in height to only 6 feet 6 inches, and it has, with its sisters, earned the nickname of " Jumbo." Even the engines in use elsewhere at Beckton, though not quite so diminutive, are kept down to 8 feet 6 inches in height, as they all have to work through confined spaces in various parts of the works

The water supplies are carried in a " saddle tank " on the top of the boiler. Although apparently so small, these engines are quite capable of hauling a load of over two hundred tons behind them.

A " Jumbo " Engine on the Gas Light and Coke Company's Railway

EXCURSION TRAINS TO BLACKPOOL TAKING WATER FROM KIRKHAM TRACK-TROUGHS.

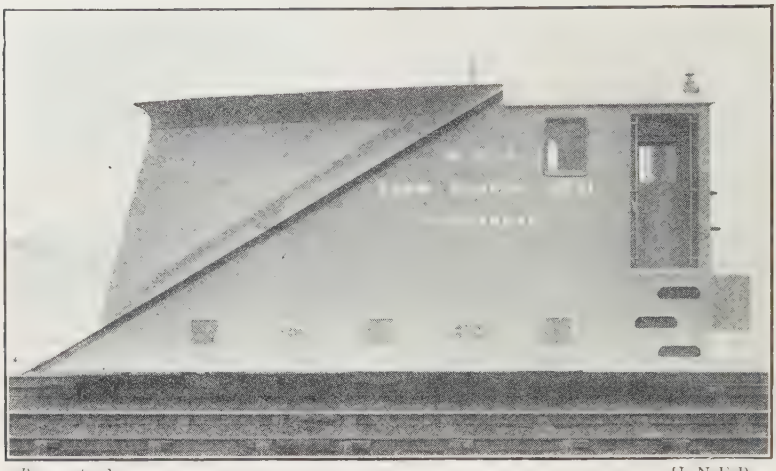
CLEARING A SNOWDRIFT ON THE BERNINA RAILWAY, SWITZERLAND

FIGHTING THE SNOW

(All photos by courtesy of the Swiss Federal Railways, except where otherwise noted)

SNOW, which we so love to see in the winter-time, is looked on with very different feelings by the railways. In the South of England, of course, we do not often have falls heavy enough to block the railways, but up in the Highlands of Scotland, or out in a country like Switzerland, handling the snow is a costly business, every winter alike. Special snow-ploughs have to be maintained in order to keep the lines clear, and the snow is sometimes too much even for them. As you will see by the picture above, the snow-plough on the Bernina Railway is having its work cut out to get through a heavy drift.

This type of snow-plough, which is shown in better detail at the bottom of the next page, is a comparatively recent invention. The



By courtesy] [L.N.E.R.

A British Snow-Plough

older method was to clear the line of snow, after a drift, by means of hand labour—a most lengthy and laborious job, as you can well imagine. Then a snow-plough was invented, in shape rather like the ram of a battleship; with two or three locomotives behind it, this plough "charges" the drifts, and shoulders them off to both sides of the line. Snow-ploughs of the type here illustrated are used in those parts of our own country where snow gives trouble.

But where really deep drifts are encountered, this last type of plough is unable to cope with them, and in countries like Switzerland, or where the Rocky Mountains of America are crossed, ploughs of the "rotary" type are always now used. The big vanes are made to revolve very rapidly by steam power, and so, cutting into the drift as the plough slowly advances, they throw the snow off to one side in a tremendous cloud, as you can see in the picture at the head of the chapter.

A Rotary Snow-Plough

Apart from the use of ploughs when the line is blocked, however, special measures are taken on

A Deep Drift on the Loetschberg Railway

railways which are subject to heavy snowfalls, to keep as much snow off the line as possible. In exposed parts of Scotland, you can see "snow fences" erected, at the side of the line, to keep the snow from drifting on to the metals when the wind is high; it is this "drifting," of course, which gives the most trouble, rather than the actual depth of snowfall—that is, the way in which the snow piles itself up after falling, in cuttings in particular.

In mountainous countries like Switzerland there are worse dangers. Sometimes, high up on the mountain-side, a mass of snow breaks loose, and begins to slide downwards. Gathering both force and speed in its descent, the dreaded avalanche sweeps away everything in its path, and not only snow and ice, but often soil, rocks and trees come down into the valleys in one huge mass. If a railway

By courtesy] [L.N.E.R.

After Clearing a Snowdrift in the Pennines

Stone Galleries or Tunnels

Stone and Timber Gallery
Special Protection Against Avalanches, Loetschberg Railway

Connaught Tunnel, in the Selkirk Mountains.

Canadian Pacific Railway.

should be met with on the way, it would fare very badly. So, where the railways are carried along the mountain-sides, as is so often the case, at points where avalanches are known to have come down in the past, or where, indeed, they are of frequent occurrence, the railway is carried under artificial tunnels, specially constructed to throw the avalanches clear over the line. You can see these galleries very clearly in the photographs of the Loetschberg Railway opposite. This line runs through a wild and inhospitable mountain region, often high up on the sides of deep valleys, where snow reigns supreme in the winter-time.

SLIPPING COACHES

IF you look in the Great Western time-table at the times of the "Cornish Riviera Express," you will notice that, although the famous "flier" makes no stop all the way from London to Plymouth, yet you may get into it and travel to certain stations which are passed long before Plymouth is reached. Westbury is one such station; Taunton is another; and Exeter is another. How is this done? It is clear that the railway company does not intend you to jump out of the window!

Look again at the time-table, and you will see in the "Cornish Riviera" column, against each of those stations, the mysterious word "Slip." Briefly, this means that at Westbury, and at Taunton, and at Exeter, coaches are dropped off the back of the train, carrying passengers to these stations without stopping to set them down.

Suppose that you visit Paddington terminus one morning just before half-past ten, in order to see how this operation of "slipping coaches" is to be performed. Walking backwards from the engine, you will note first of all the through coaches for Penzance, St. Ives, Falmouth and perhaps one for Plymouth, and then the continuous passage, or "gangway," connecting the coaches, comes to an end.

[G.W.R.

SLIPPING COACHES AT BEDMINSTER, BRISTOL
Notice the special slip tail-lights.

The next coach is one of the two forming the "Exeter slip." If you look very carefully at the front of it, you will see various unusual fittings. There is, for example, a motor horn. The connection between the two halves of the rubber hose-pipe which you always find between the coaches of a passenger train (and which provides the means whereby the engine-driver is able, from the engine, to apply the brakes on every carriage right down his train) is much more complicated than usual.

And then, very particularly, you will notice that the hook on the slip-coach, which holds the coupling of the coach in front, has a hinge in it. If this hinge were to swing outwards, the coupling would be released, and the train would break in half; but it is held tightly in position by means of a sliding steel bar, or wedge, on top. The front compartment in the slip-coach is for the slip guard, who will be responsible for severing the train at the right place; and in

this compartment you will see the lever by means of which the sliding bar, to which I have just referred, is withdrawn.

To cut a long story short, if you were allowed, as a special privilege, to travel with the Westbury slip guard, as the express neared Westbury you would see him begin his preparations. Within about a quarter of a mile of that station he would pull his slip lever right over ; the hook would swing round on its hinge and let go the coupling ; and the slip would be " off." Automatically the brake hose-pipe on the back of the express itself stops itself up, " sealing the vacuum," as it is termed ; otherwise the express would be brought to a sudden halt.

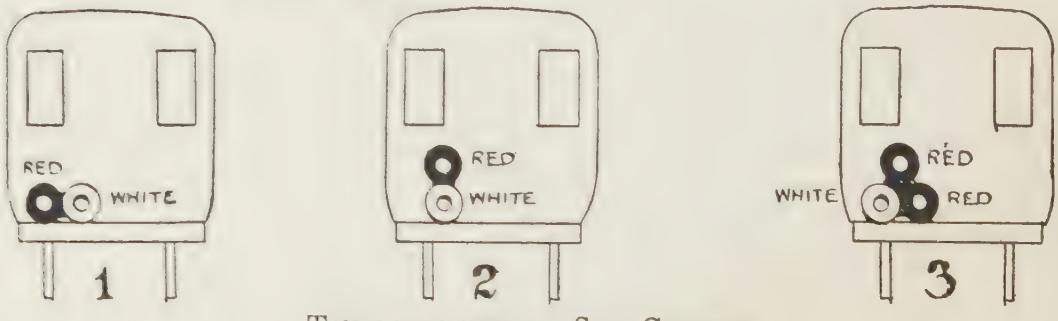
In pulling his lever over, the slip guard also applies the brakes slightly on the slip portion, so that the latter quickly draws away from the express. Then he signals out of his side-window to the driver

SLIPPING COACHES AT BROXBOURNE, L.N.E.R.
The slip guard is just waving his green flag to the driver.

with a green flag, to show that he has "slipped" successfully, and the last thing remaining is carefully to bring the slip to rest at the station platform by the use of his brakes. The motor-horn in front of the slip-coach, which is worked with a foot-bellows, is to warn people that the slip-coach is coming; this is very necessary, as men employed on the station or on the track are apt, unthinkingly, to get on to the line after the express has passed, forgetting that the slip is coming along behind.

The Great Western Railway does a great deal in the way of slipping coaches; there are, in fact, over thirty slips daily at various points on that system. On other railways, however, the practice is gradually dying out. The chief objections to slipping are that each "slip" must have its own guard, and also needs specially-fitted coaches. In no country other than our own can slip carriages be found at all.

You can always see when a slip portion is attached to an express, by means of the peculiar arrangement of red and white lamps carried on the back. These may be seen on the tail of the slip in the Great Western Railway photograph on page 22, and are further explained in the little diagrams below. This is but one of many special precautions which must be taken in cutting into two halves an express train travelling at full speed.



TAIL-LAMPS USED ON SLIP COACHES

1. On the rear coach, when only one portion is being slipped.
2. On the back of the second slip portion, if there are two slips.
3. On the back of the third slip portion, if there are three slips.

[F. E. Mackay *Photo*]

BIRMINGHAM EXPRESS AT FULL SPEED, G.W.R.

RIDING WITH THE ENGINE-DRIVER

IF you are anxious to ride with the driver on the footplate of a big express engine on some famous train, I am bound to tell you in advance that you will not find it easy to arrange. A suitable piece of "paper" handed over to the gentlemen on the engine certainly will not make it possible. For the railway people are *dreadfully* particular! If you make an application to travel on the engine, you will get a very nicely worded reply; but it will really mean "Certainly not. In no circumstances whatever!"

This is because "Safety First" must, on the railways, be the very first consideration, all the time. Nothing is allowed to distract the driver and fireman from their most responsible duties. So you must just let me tell you, as best I can, what it feels like; I am one of those fortunate people who have what are called "satisfactory reasons" for wanting to accompany the driver, and sometimes I am allowed to do so.

You do not put on your best suit to ride on the engine. Personally, I always wrap myself up as well and thoroughly as I can in the oldest

clothes, and cover up all my face except enough to see and breathe through; it leaves less to be scrubbed when the ride is over! The big driver's shelter, or "cab," rushing through the air at speed, makes a strong suction, and so the smoke and steam from the chimney get sucked back into the cab, especially when you are running through tunnels, depositing itself freely over the occupants.

Neither is the footplate a place for nervous or delicate people. To those unaccustomed to it, the first necessity is that of holding on tight, as the shaking up that you get is tremendous. You sometimes feel as though the engine would shake herself to pieces before the end of the journey! An engine is not "sprung" like a dining-car; and then in addition you have all the swaying that is produced by the pistons moving to and fro, and the constant swinging round of the heavy parts of the machinery.

And now what about the crew on the engine? What has the fireman to do? A great deal more than you might think. Firing does not simply consist in opening the fire-hole door, and throwing in shovelsful of coal just anyhow, now and again. The locomotive boiler has to produce steam at a quicker rate than any other type of boiler that you could name, of equal size; and the firing must be carried out quite scientifically, if the engine is to do her work properly. This means dropping the coal in just the right position on the fire-grate, so that the draught may come up easily through the fire, and the coal burn through properly.

Then the quantity of coal to be handled on a long journey is nothing to be despised. When last I travelled on the engine of the famous Great Western "Cornish Riviera Express" from London to Plymouth, the fireman shifted some three and a half tons of coal from the tender on to the fire in the space of a little over four hours—a perspiring job indeed! The fireman has also to see that the boiler is properly supplied with water, and many are the anxious glances he

By courtesy] [G.W.R.

ON THE FOOTPLATE OF A GREAT WESTERN EXPRESS ENGINE

The driver has hold of the regulator handle. Above his hand (looking rather like a pepper-pot with a handle) is the ejector by which the vacuum brake is applied. Immediately behind his back is the wheel and screw of the reversing gear. The fireman is shooting coal through the fire-hole door; above his neck is the boiler water-gauge, and in the top left-hand corner of the cab is the pressure-gauge; behind the fireman's back are seen lubricators, serving important parts of the motion.

may be seen to direct towards the water-gauge and the pressure-gauge during the journey.

And then there is the driver. His is a more scientific task still. He has to see that the steam produced by the efforts of his fireman is put to the best use. The big handle which his hand rarely leaves is the regulator ; it controls the passage of the steam from the boiler down to the cylinders. Then he frequently controls the use of the steam in another way, by what is called the valve-motion or "reversing gear."

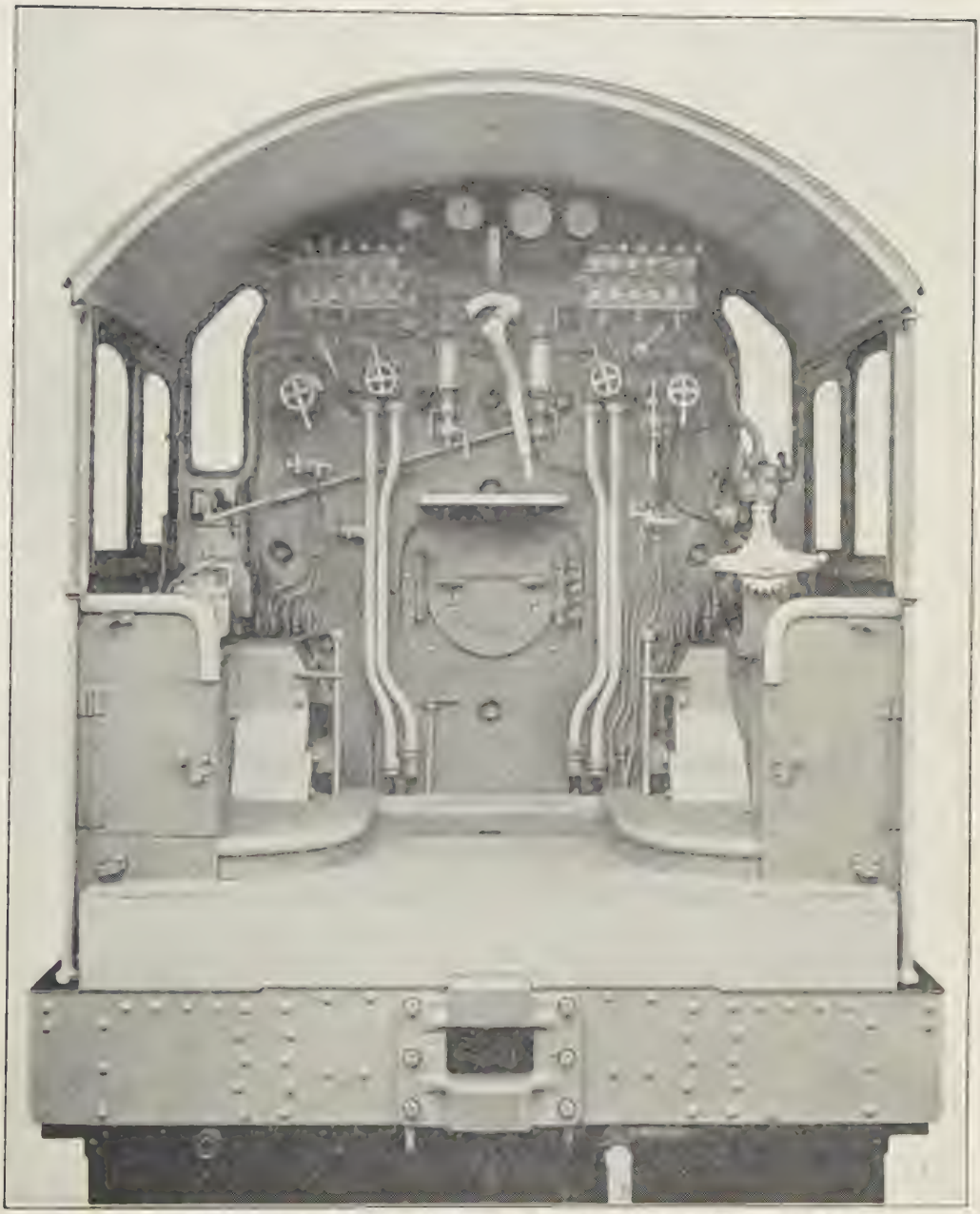
It is through the slide-valve or piston-valve that the steam actually enters the cylinder, and these important valves both control the admission of the steam, and also cut it off at exactly the right moment. By the valve-motion the driver can regulate the point at which steam is " cut off " ; for the rest of the forward motion of the piston the steam expands, ere it is thrown out of the chimney in the " puffs " that are so familiar to you. When the engine is starting, the driver uses a " late " cut-off ; as it gets into speed, and the boiler can no longer supply steam so fast as to fill the cylinders at every revolution of the wheels, he brings the cut-off back, making more and more use of the expansive possibilities of the steam in the cylinders.

So the whole science of driving consists in manipulating the regulator and the valve-motion in such a way as to meet every change of gradient, or load, or of the booked speed of the train. One needs to watch a driver at work, especially over a hilly stretch of line with a fast and heavy train, to realise how much brain-work is necessary for driving. And then, equally or even more important, there are all the signals to be watched ; the driver dare not neglect a single one.

All this means, as you can readily understand, a most intimate acquaintance with every yard of the road over which the driver has to travel. And this brings me to the way in which the footplate is reached. There is no " Royal Road " to driving. The first stage of

The "Southern Belle" Express, Southern Railway.

From photo by F. E. Mackay



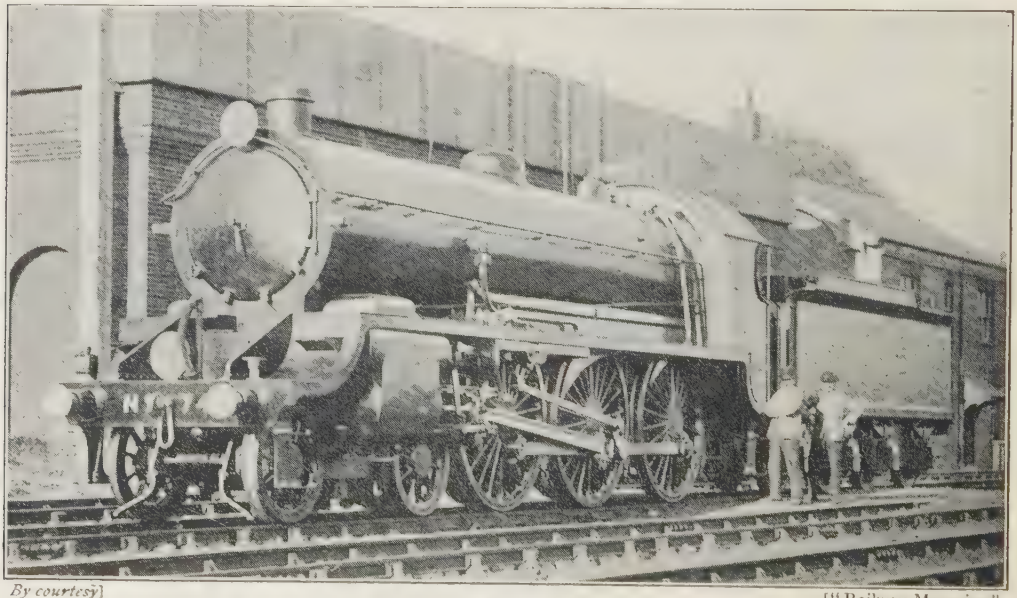
CAB OF A MODERN L.N.E.R. EXPRESS ENGINE, GREAT CENTRAL SECTION

Regulator handle in centre, with fire-hole door below; reversing gear on right-hand side, with vacuum brake ejector above; water-gauges each side of regulator; sight-feed lubricators at top right and left corners of cab, with pressure, brake and superheater gauges between; the four small wheels each side of regulator work the injectors, admitting water to boiler.

training is the humble work of cleaning engines, inside and out, a job begun in boyhood's days. After some years at cleaning, during which the boy is learning how an engine is built, there comes firing, first on a little shunting engine, then on goods trains, then slow passenger and lastly express passenger trains.

Then, ere the fireman can take his place as driver, there is a strict examination on what he knows of the engine, and if he comes through, as well as through the rigid tests of health and eyesight that take place from time to time, at last he takes his place " in command " on the footplate. Again he has to rise slowly, from the shunting engine until he reaches ultimately the footplate of the big express locomotive.

The pictures on pages 27 and 29 give you a good idea of the inside of the shelter, or " cab," in which the driver and fireman work. Cabs in these days are much bigger and more comfortable than they were ; extended roofs, to keep out the weather, side-windows, and even seats are often now provided.



By courtesy] ["Railway Magazine"

READY FOR THE ROAD—A SOUTHERN RAILWAY "KING ARTHUR" AT EXETER

Photo] [F. R. Hebron

G.W.R. "Pendennis Castle" Working the Leeds Express, L.N.E.R.

EXCHANGING LOCOMOTIVES

AT one time and another, railways have grown so interested in the running of their neighbour's engines, that "exchanges" have been arranged, and the strangers have had an opportunity of showing their paces over unusual routes. In 1909, for example, a London and North Western "Precursor" engine exchanged duties with a Great Northern "Atlantic." Another engine of the former type tried its hand at running the "Sunny South Special" through to Brighton, while a Brighton "tank" engine worked the same train, turn-and-turn-about, to and from Rugby. Then, in 1910, a North Western "Experiment" locomotive changed places with the Great Western four-cylinder engine "Polar Star"; this was a notable event, in which the G.W.R. had considerably the better of it. But the most famous of all these exchanges, without any question, was that of 1925, when the Great Western Railway lent "Pendennis Castle" to the London and North Eastern Railway in exchange for a big

"Pacific." The latter had to work the tremendously hard "Cornish Riviera" express for a week, and you can see her in the second picture starting away from Paddington; "Pendennis Castle," as seen in the first picture, had to work 480-ton Leeds expresses every day on the L.N.E.R. main line. Driver and fireman came over with their engine in each case, in order to give the giant competitors the best possible chance, and each of the crews had a week's trial running over the test routes before the real test week began. Not only did the rivals run over strange routes, but they had strange diets as well, "Pendennis Castle" being fed on Yorkshire coal, while the L.N.E.R. "Pacific" consumed the best Welsh coal to which her rival was accustomed. Each of the two engines succeeded in doing each other's work quite well, but the smaller engine managed on a lower consumption of coal, which was a feather in the cap of her builders at Swindon.

By courtesy (L.N.E.R.

L.N.E.R. "Pacific" Leaving Paddington with G.W.R. "Cornish Riviera" Express

LETHBRIDGE VIADUCT, ALBERTA

CROSSING A CONTINENT

THE STORY OF THE CANADIAN PACIFIC RAILWAY

(All photos by courtesy of the C.P.R.)

ONE of the most remarkable railways in the world is the great Canadian Pacific, whose services girdle over one-half of the globe. Not only does it work 14,500 miles of line in Canada, from east right across to west, but it also runs its own steamer services across the Atlantic from England to Canada, and again across the Pacific from Vancouver to China and Japan.

The history of its construction, if only I had time to tell it, is a fascinating tale of the overcoming of difficulties, and of the obstacles placed in the way of the builders by Nature. Some of the line through the wild country on the north side of Lake Superior, in Southern Ontario, cost as much as £140,000 per mile; in fact, a stretch of only 200 miles ran the builders into two and a half millions sterling of money. You will realise the kind of engineering that has been carried out as you look at these photographs. For example, the spidery Lethbridge Viaduct above is 47 feet over one mile in length, and no less than 314 feet above the bed of the river below, at its highest point; 12,200 tons of steel were used in its construction.

THE "TRANS-CANADA EXPRESS," MONTREAL TO VANCOUVER

Then, as the line stretches out further west, it reaches the vast natural barrier presented by the Rocky Mountains, disputing its passage to the west coast of Canada. After leaving the western city of Calgary, the line climbs gradually up the valley of the Bow River, through a natural gateway in the mountains known as "The Gap," until it reaches the summit level of 5329 feet above sea-level, in the Kicking Horse Pass. This is called the "Divide"; it is the top of the watershed, where the waters of the mountain glaciers split to run eastwards to the Atlantic, and westwards to the Pacific Ocean.

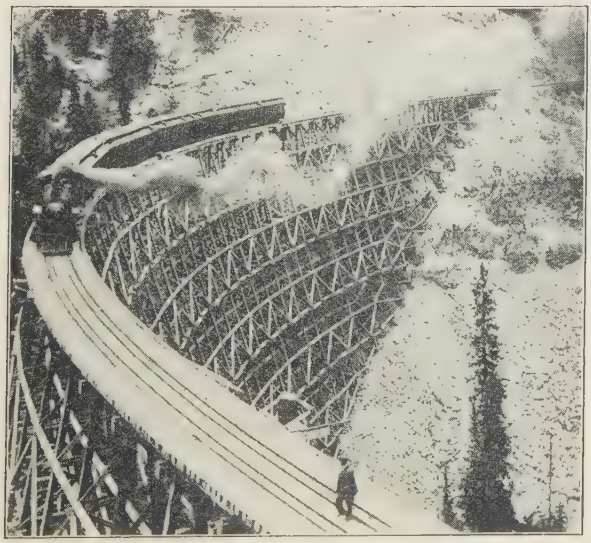
From here the line has to drop sharply into the deep valley of

FREIGHT YARDS AT WINNIPEG

Snow-shed in the Rockies

the Columbia River, and from Hector down to Field, in the early days of the railway, the "Big Hill," as it was called, involved a fall of 952 feet in no more than 4 miles, which meant a fearful expense in operation, owing to its steepness. Twenty-five years later a deviation was made, and some remarkable spiral tunnels, like those of Switzerland, now reduce the steepest part of the line from a grade of 1 in 22 to 1 in 45—a big difference.

After the Rocky Mountains comes the parallel range of the Selkirks. The engineer, Rogers, found a narrow passage for the railway through Rogers Pass, but this meant a climb of 1768 feet in the 67 miles from Golden to the summit, 4309 feet above the sea, followed by a drop of no less than 2857 feet in the next 22 miles beyond the pass. The heavy grades that were involved by these big differences in levels have recently been overcome by the driving of the Connaught Tunnel, which figures in the coloured plate at an earlier place in the book. This tunnel is the longest in America, and its five miles were bored in the record time of 704 days. The cut-off has reduced the height to which



Old Trestle Bridge

FOUR TUNNELS IN THE FRASER RIVER CANYON

the line has to climb in the Selkirks by 550 feet, has shortened the distance by 4½ miles, and has, of course, very greatly eased the grade, so that the two and a half millions of money spent on its construction has been well worth while.

Incidentally, the snow problem in these wild mountain surroundings is as serious as it is in countries like Switzerland, and probably more so. On page 35 you see one of the many "snow-sheds" which have been built at points where avalanches are known to be frequent, in order to throw the snow clear of the line as far as possible. The kind of engineering which had to be undertaken along the banks of the Fraser River, on the way from

A Country Station in Canada

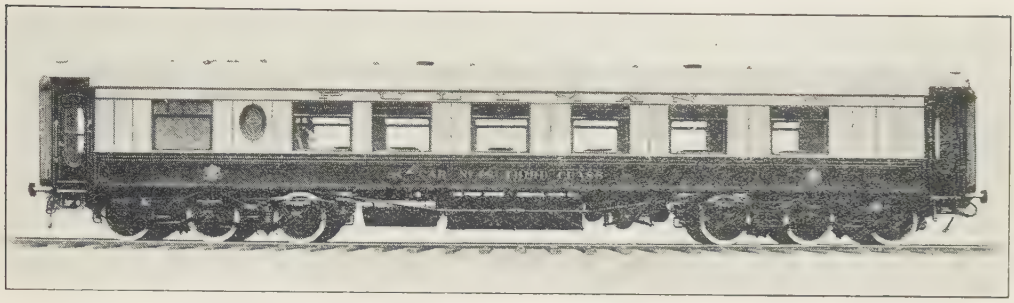
the Selkirks to the west coast, is clear in the photograph opposite, which shows four tunnels and a bridge over the river in a bare half-a-mile of railway. It is all the more remarkable to realise that the original line, from Montreal to Vancouver, 2900 miles, was completed in the short space of 15 years, despite the engineering difficulties I have described. Much of the distance, however, was across the flat prairies of Manitoba, Saskatchewan and Alberta, where construction was comparatively easy.

Windsor Station, Montreal—The Train-Sheds

The mainstay of the traffic over the Canadian Pacific Railway of to-day is the grain produced in those vast areas of prairie. The amount of that traffic you may understand by looking at the photograph on page 34 of the enormous freight yards at Winnipeg—the capital of Manitoba and the central point on the line—where no less than 120 miles of sidings have been laid. Present-day passenger travel on the C.P.R. is seen in the picture of the luxurious " Trans-Canada Limited " express, which leaves Montreal every day at 6 o'clock in the evening, and reaches Vancouver, on the other side of the Continent, at nine in the morning four days later.

The pictures of Canadian stations will interest you ; you see how, in a country where there are exceedingly cold days in the winter, people do not wait for their trains on the platforms, but indoors, and this probably explains why the interior of many of the biggest stations in America and Canada are so beautifully designed, as in the photograph below.

INTERIOR OF WINDSOR STATION, MONTREAL



THIRD-CLASS PULLMAN CAR

RAILWAY COACHES—PAST AND PRESENT

A COMPARISON of the photograph above with the picture at the top of the next page, forcibly reminds us how railway travel has been revolutionised in the space of some ninety years On the London and Birmingham Railway, in 1837, first-class passengers had covered coaches in which to ride, while second-class people had nothing more than a canopy over their carriages, and the third-class travellers were not much better off than they would be in cattle-trucks. Nowadays, there is scarcely an express train running in the country which does not include either restaurant cars or Pullman cars in its formation, for both first-class and third-class passengers.

The carriages of early days were carried on four wheels only, and were probably only about twenty-five feet long. From four wheels we progressed to six wheels, and from six wheels to eight wheels. Then the principle of carrying the coaches on " bogies " was introduced, whereby each end of the eight-wheeled coach rests on small four-wheeled trucks, or " bogies," pivoted in the centre, and this enables the coach, like the front end of an express engine, to swing freely round the curves, especially when the train is running at speed, so making for smooth riding. Some of the longest and heaviest coaches, as the Pullman car at the head of this chapter, are carried on six-wheeled bogies. But the practice over here is generally

By courtesy] [L.M.S.R.

WHAT PASSENGER TRAVEL WAS LIKE IN 1837

to stick to the four-wheeled bogie for coaches, the longest vehicles so running in the country being the 70-foot and 73-foot coaches of the Great Western Railway.

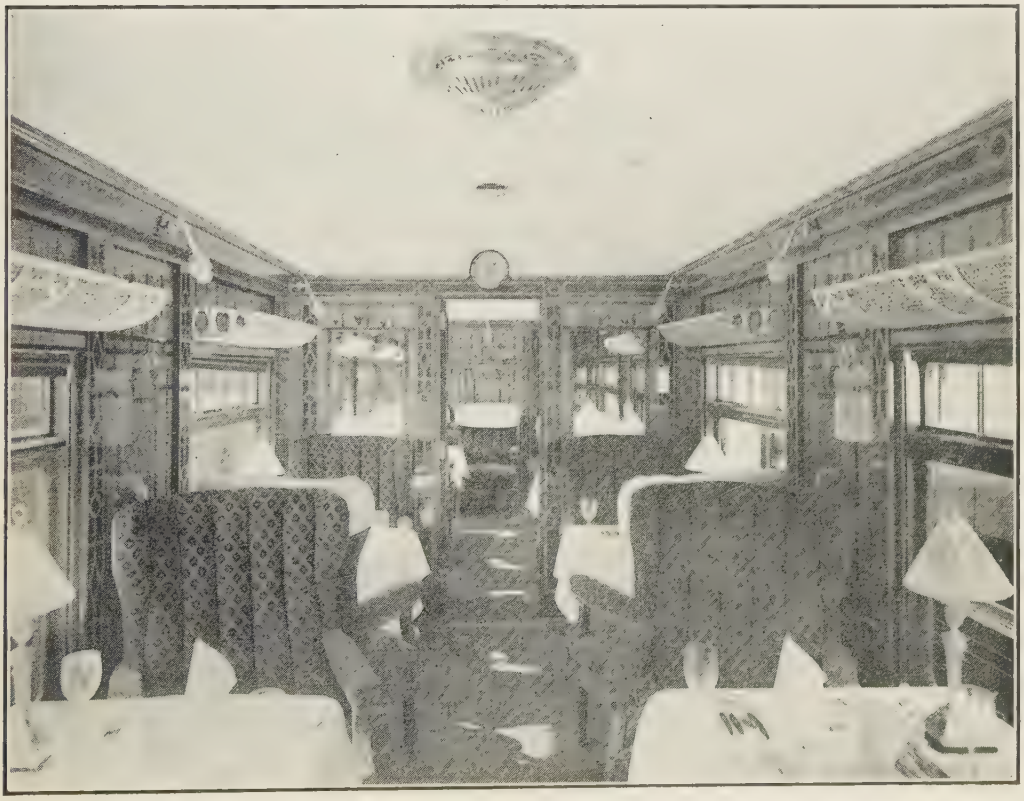
The latest way of building carriages is that illustrated at the top of page 44, which shows a set of "articulated" coaches on the London and North Eastern Railway. In this arrangement, the ends of adjacent carriages are carried on only one bogie, so that instead of the three vehicles—first-class dining-car, kitchen car and third-class dining-car—being carried on six bogies, only four are used, and the weight of the "set" is correspondingly reduced. There are various kinds of articulated coaches now at work on the London and North Eastern, including dining, sleeping and corridor carriages, old six-wheeled coaches rebuilt as articulated sets, and many complete

By courtesy] [L.N.E.R.

THE FIRST BRITISH DINING CAR, 1879

suburban trains. But you cannot uncouple any part of an articulated set, of course, and use it by itself !

In carrying suburban passengers, it is the maximum possible seating space that is wanted in the minimum of train weight, so that the engines shall be able to make smart starts from their many stops, and get up speed quickly. A suburban train of the Great Eastern section of the L.N.E.R.—which probably has to handle a denser suburban traffic with steam locomotives than any other railway in the world—consists of ten articulated coaches and seats 872 passengers, six a-side in the third-class and second-class, and five a-side in the first-class. The average weight of coach is thus less than one-quarter of a ton to every passenger conveyed, when the



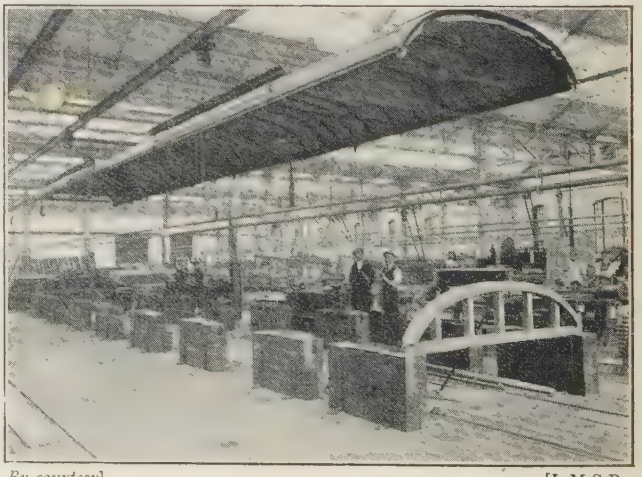
Interior of First-class Pullman Car

[By courtesy] [L.M.S.R.

COACH-BUILDING—THE FRAME

train is full. The French have tried to solve their suburban problem round Paris, on one line at least, by using "double-deck" carriages like tramcars, as shown on page 46. But we have not sufficient room under our bridges to do the same here.

The case is very different with the main line coaches, however. Corridors and lavatories have all cut something away from the seating space of the coaches in which they are installed; and dining, sleeping and Pullman cars are even more costly in this respect. For example, the Pullman car, whose interior—like a drawing-room on wheels—is shown on page 41, seats only twenty-one people, and weighs rather over forty tons; this means two tons of coach weight to every passenger conveyed. You will thus understand why extra fares have to be paid for the luxury of Pullman travel. The name "Pullman," by the way, originated on the other side of the Atlantic, where an American named Pullman thought there would be a ready market for specially comfortable travel at special prices, and started



[By courtesy] [L.M.S.R.

COACH-BUILDING—THE ROOF

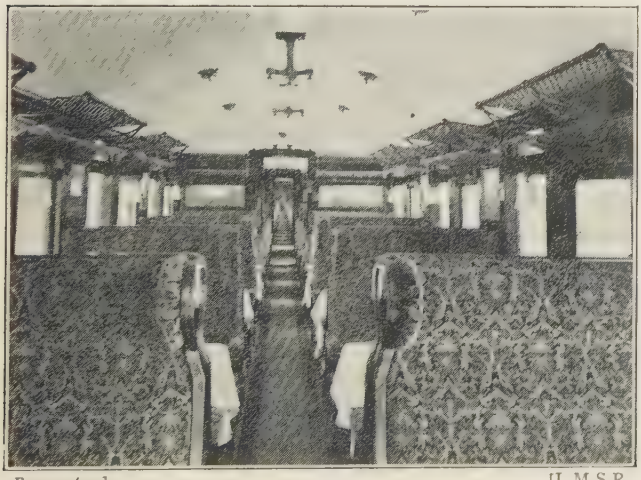
to introduce the carriages which bear his name. In America and Canada Pullman cars correspond to our first-class over here, and are in universal use.

By courtesy] [L.M.S.R.

ASSEMBLING THE COACH

It was probably the Pullman car that introduced the demand for "open" coaches on our own main line services. Some railways, like the London, Midland and Scottish, are now building open cars very extensively, and you find them on nearly all the chief L.M.S. trains to-day.

The whole course of the building operations at Derby Works, by what is called "mass production," is shown in the interesting series of pictures on these two pages. First of all you see the frame of the coach, and then, in the second picture, the "jigs," on which the roof has been made, with the roof itself raised in the air ready for the assembling of the coach. This is to take place in the background of this picture, where the frame and the two sides are waiting ready. The third picture of the series shows the sides and ends of the coach being cramped on



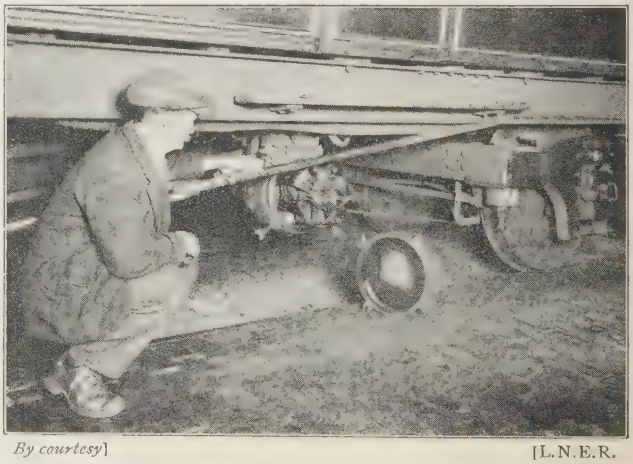
By courtesy] [L.M.S.R.

THE LATEST L.M.S. TYPE COACH COMPLETE

LATEST "ARTICULATED" DINING CAR SET, L.N.E.R.

to the frame, and the roof about to be lowered into position. The next operation will be the fitting of the inside, and the dropping of the whole vehicle on to the bogies, when it will become the beautiful carriage shown in the last photograph of the four.

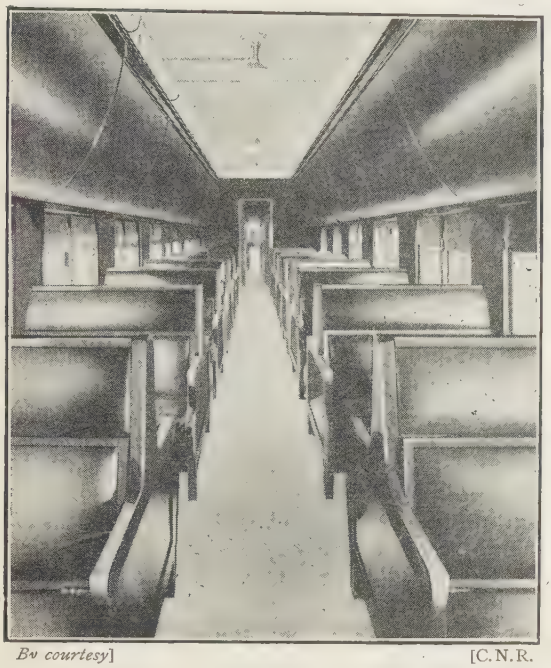
The open type of coach is universal on the Continent of America, and on page 45 you see a typical Canadian "Colonist" car, corresponding to our third-class over here. In this class of vehicle, the seats are so arranged as to make beds at night, and the two sides of the roof let down to make upper berths also, so that beds are provided for everyone on the train. This is essential on such long journeys as those which cross America, taking several days in succession. In Great Britain sleeping accommodation is provided for first-class passengers only, but the journeys are much shorter. No sleeping-cars could be more comfortable than the latest in this country, which are provided with real beds, each in its own separate room, and are furnished with every imaginable comfort.



By courtesy] [L.N.E.R.

MAKING ELECTRICITY ON A RAILWAY COACH

There are two photographs on page 47 which



By courtesy] [C.N.R.

CANADIAN "COLONIST" CAR

give some interesting details of how coaches are designed. In the foreground is the big "gangway" through which you walk when you are on the way to the dining-car. Under the gangway you can see two pipes. The one to the left is the very important brake connection; joined up to the corresponding pipe on the neighbouring coach, it makes a through communication from the engine right through to the last coach on the train, whereby the driver, when he applies the brake, applies it not only on his engine, but also on every carriage behind him. This is why passenger trains are able to make such rapid stops, as compared with goods trains.

There are two types of "continuous" brake in general use; the one shown in these pictures is the "vacuum" brake, whereby a vacuum in cylinders under each vehicle is the "reservoir" of

By courtesy [C.P.R.

STANDARD CANADIAN SLEEPING-CAR

Suburban Train, L.N.E.R. (Great Eastern Section)

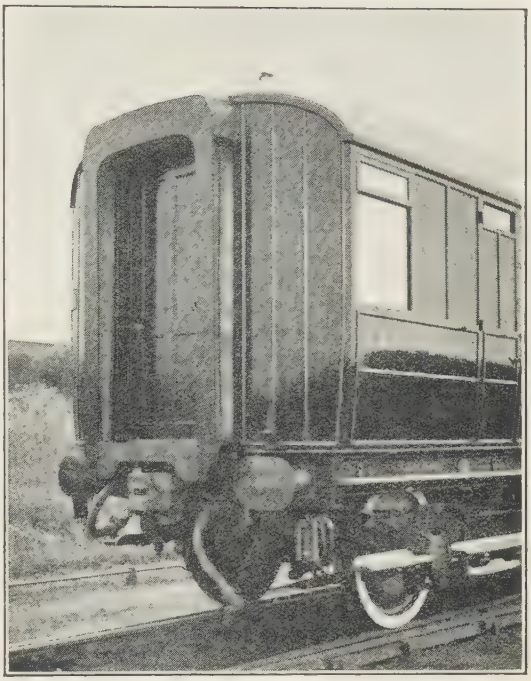
power, and the destruction of the vacuum by the driver, who opens a suitable valve, applies the brake. The Westinghouse brake is also in common use ; in this case power is supplied by compressed air.

The other pipe, on the right-hand side, carries the steam which warms your compartments in the winter ; it also comes direct from the engine. In the old days there used also to be a cord running along outside the coaches, just above the doors, connected to the engine whistle, so that a passenger could give warning to the driver if anything was wrong, but this is now replaced by the handy chain inside the compartment. Pulling this partially applies the brake on your own carriage, and also sounds a shrill whistle at the end of the coach, and causes

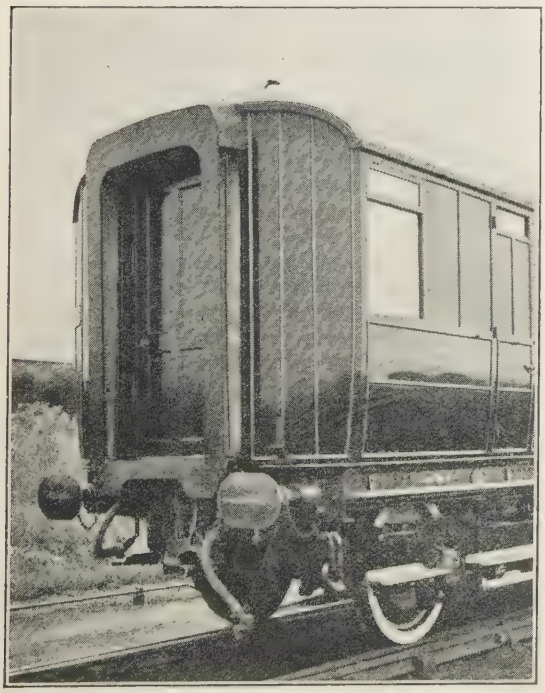
A " Double-deck " French Suburban Coach

a little red signal to project outwards; in this way the coach concerned is instantly found.

The other, and most important end fitting of all is, of course, the coupling. In the earliest days, carriages were just connected by chains, as are so many of our goods wagons today, and starting and stopping were jerky and unpleasant affairs for the passengers. Then the chains gave way to the screw coupling, which enabled the distance between the coaches to be adjusted until the buffers just nicely touched, and the jerking was done away with. Now we have gone further still than this, with the automatic coupling, first used here on the East Coast trains of the L.N.E.R. in 1898.



Automatic Coupler in Position
L.N.E.R. Vestibuled Coach



Automatic Coupler Out of Use
L.N.E.R. Vestibuled Coach

In the lower of these two photographs the coupler is swung out of position, so that the ordinary screw coupling can be used on the hook (as is necessary when one of these coaches has to be coupled up to a vehicle without the automatic coupling). It is in shape like a hand partly clenched; and when in correct position, as in the upper picture, it meets the coupler of the next

coach, the two literally " shake hands "—and do not leave go again ! Another valuable outcome of this type of construction, is that these automatically-coupled coaches have been proved on several occasions to keep exactly in line when a train has been derailed, instead of the dreaded telescoping of one coach into another, which has been the source of so many deaths and injuries in railway accidents.

An alternative and ingenious way of providing against telescoping was that adopted on many of the coaches of the late Great Central Railway, and illustrated below. Here the coaches are fitted at the ends with heavy castings, shaped like teeth, to bite solidly into each other in the event of an accident.

Another interesting detail of coach equipment is seen in the photograph at the bottom of page 44, which shows how coaches make their own electricity for lighting. A belt off the axle drives the dynamo in the foreground, and the electricity from this is taken to accumulators under the coach, where it is stored for use as required. In the latest restaurant cars of the London and North Eastern, this electricity is being used for cooking also, instead of gas.

Corridor Train with " Anti-Telescoping " Appliances, L.N.E.R.

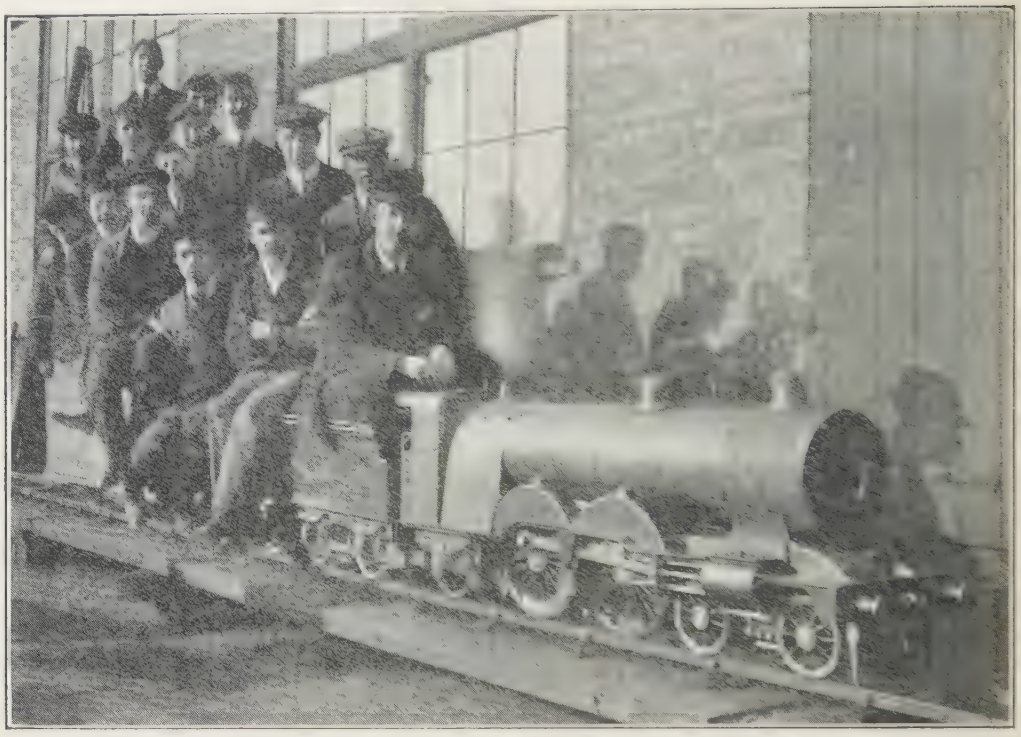
THE TINIEST ENGINE THAT EVER PULLED A TRAINLOAD OF PASSENGERS

RAILWAYS IN MINIATURE

(All photographs by W. J. BASSETT-LOWKE)

THERE are few things of more fascinating interest than miniature railways. Many of you, no doubt, have your own "private" lines, laid in temporary fashion round the dining-room floor, or more permanently in the attic or even in the garden. But these are railways on a very, very tiny scale; and I do not suppose you have ever experimented in the way of trying to induce your model engine to pull *you!* For all that, it is surprising to realise what has been done in the matter of passenger-carrying on the most miniature of gauges. Here is a picture of a little engine which, at the Model Engineer Exhibition of 1924, succeeded in pulling no less than three full-grown people, and on a track whose gauge was no wider than 2 inches!

And what about the second picture in this article as a test of miniature locomotive capacity? You see some fifteen hefty North-



TESTING A MINIATURE "ATLANTIC" ENGINE AT NORTHAMPTON

amptonshire men and boys trying the results of their handiwork at the well-known Bassett-Lowke model railway works. The gauge on which this engine runs is only 9½ inches, and the scale is only one-sixth of full size; yet the weight she is pulling cannot be far short of a ton! Actually this engine is an exact model of one of the familiar Great Northern "Atlantic" locomotives.

But I am more concerned with real passenger-carrying railways on a very small scale. The tiniest passenger railway in the world is probably the Eskdale Railway in Cumberland. The gauge—that is, the distance between the rails—is only 15 inches. Another line on the same gauge has just been opened between Romney, Hythe and Dymchurch, on the south coast of Kent. If you have not yet run across these unique railways, you have probably seen short lines of a similar kind in the pleasure gardens at Rhyl, Southport, Black-

ROUNDING "CAPE HORN" AMONG THE MOUNTAINS OF CUMBERLAND—THE ESKDALE RAILWAY

ON THE SANDY SHORES OF CARDIGAN BAY—THE BARMOUTH & FAIRBOURNE RLY.
TWO VIEWS ON 15-INCH GAUGE MINIATURE RAILWAYS

A Heavy Load

pool or elsewhere, laid down for amusement purposes, and worked with scale model express engines. But the Eskdale Railway, although worked in just the same way with scale model engines, is a real business line ; it forms, indeed, the only means of communication up the valley of the Esk, and is 7 miles long.

In the summer-time, when the line is a centre of attraction for many miles round, passengers are carried in little open cars, as you see, each holding eight people, two abreast. Sometimes train-loads of a hundred people and even more have been made up. For wet weather and for the winter, however, there are some closed cars ; needless to say, there is no room to spare inside, although, if you double yourself up very carefully as you get in, it is possible for you to avoid banging your head on the roof !

A Leafy Tunnel on the Eskdale Railway

Engine Headlamps and Discs on the Southern Railway.

Just to show what could be done on so narrow a gauge as 15 inches, a sleeping car was actually built to run on the line! It has four berths, two on one side and two on the other—an "upper" and a "lower" berth in each case—and I believe it has been used as reserve sleeping accommodation for the staff on the Eskdale line when they have been very short of room.

"Colossus" on the Eskdale Railway
It is hard to tell that this is not the "real thing!"

The engines are a beautiful copy in miniature of full-size machines. There are three types—4-4-2, 4-6-2 and 2-8-2—the last-mentioned being used for the hardest pulling. Although the engine "Colossus," which appears in several of the illustrations, only weighs, with her tender, some 3 tons all told, she has done some wonderful work. On page 55 you can see her under test on the private line of the Duke of Westminster at Eaton Hall, in Cheshire.

Inside an Eskdale Railway Coach

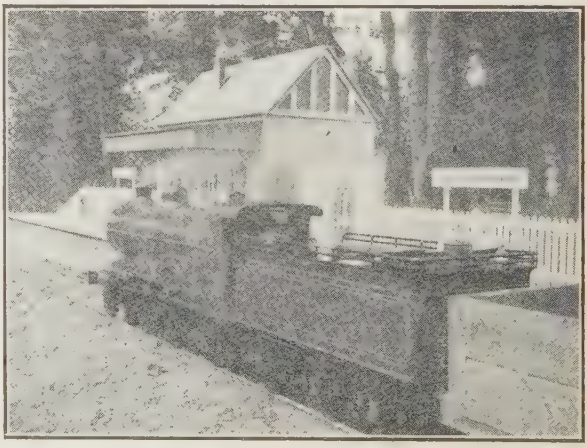
The "driver," by the way, is the writer of this book; we succeeded in pulling a load of 17 tons on that occasion, and in coaxing a

Crossing the "Forth Bridge"
Staughton Manor Railway

speed of no less than 35 miles an hour out of this little machine. Seeing that "Colossus" is only planned to a scale of one-quarter full size, this speed was really equivalent to a "full-size" speed of something over 100 miles an hour! It was a very thrilling experience.

The driver, as you can see, sits in the tender of the engine, and he has to act as driver and fireman rolled into one, because he has no room for a companion. On such a line as the Eskdale, which has some very steep and awkward switchback gradients, working the engine is by no means an easy job, especially when a big load of passengers is being hauled for 7 miles on end. It is the simplest thing imaginable to get "stuck" for want of steam, and the constant curves in the road, such as the rounding of "Cape Horn," call for constant watchfulness.

There are quite a number of railways in the country with gauges of 2 feet and upwards. You have probably seen some of the "toy" railways in North Wales, several of which, as a matter of fact, are anything but toys. The Festiniog Railway, for example, which connects the slate-quarrying district of Blaenau Festiniog, in the



A Realistic Station on the Staughton Manor Railway

Welsh mountains, with the coast of Cardigan Bay, at Portmadoc, is a very busy line indeed. It has been laid out with a perfectly even gradient from the quarries down to the sea; so it is possible to run long trains of slate to the coast for shipment, without any engine being used at all. The engines then haul the empty wagons back to Blaenau Festiniog, to fetch the next load.

A Test Load of Coal, Eaton Hall Rly.

Curious double-ended locomotives of the Fairlie type are used on this railway. They are really like a couple of engines arranged on one frame, and under the control of only one driver and fireman. The cylinders and the motion are mounted on swivelling trucks or "bogies," under each end of the engine. This arrangement makes it possible to build a powerful engine on a small scale whose weight is spread out over a good length of track, but which yet readily adapts itself to the curves.

The possibility of laying very sharp curves is one of the great advantages of a narrow-gauge railway. In mountainous country a narrow-gauge line can be laid in such a way as to "hug" the steep hill-sides, without tremendous expense in cuttings and embankments, bridges and tunnels. The cost of track, engines, carriages and wagons is much less than those of the standard gauge, too, on account of their smaller scale.

A Pretty Corner, Sand Hutton Railway

BOURNEMOUTH EXPRESS, SOUTHERN RAILWAY

The engine is carrying the " head-code " for the Southampton route ; the number on the disc below the chimney is the number of the train.

ENGINE HEADLIGHTS AND DISCS

(All photographs by F. E. MACKAY)

IN nearly all the pictures in this chapter you will notice that the engines are carrying curious round sheet steel " discs " in front, some painted white, and others having crosses or other devices painted on them. It is hardly necessary to say that the discs are not used for decorative purposes. Generally speaking, by the way that they are painted, and also the way in which they are arranged in front of the engine, they indicate the route that the train is going to follow. Each engine has its own supply of discs of different kinds, and it is the fireman's duty, before the train starts, to see that the right discs are in their right places, so that signalmen and others, as the train approaches, may know readily where it is going. This is most important on such a system as the Southern Railway, which has so many terminal stations in London, and so many ways of reaching most of the towns that it serves by means of its network of lines.

BRIGHTON PULLMAN TRAIN, SOUTHERN RAILWAY
Carrying the old discs (now done away with).

In the old days, many different kinds of discs were used — round, oval, square, and diamond-shaped, and with various spots, crosses and other designs in different colours painted on them. The difficulty was, however, that this great variety by day could not be distinguished at night, when the only coloured lamps the engine can carry are green and blue, in addition to white. So in these days the "codes," or arrangements of discs, are being simplified as much as possible, and the discs used are being cut down to plain white, white with black cross, or black or green centre, for which at night a green lamp is carried, and white with a blue centre, indicated at night by a blue or purple light.

The other main lines of railway, whose main routes are not, perhaps, so complicated, do not trouble to carry discs, but make their indications by means of the ordinary headlamps, unlighted in the daytime and lighted by night. No attempt is made to indicate routes at all, generally speaking; the headlamps just show

WEST OF ENGLAND EXPRESS, SOUTHERN RAILWAY
The two white discs form the "Salisbury" line code, and the black centre disc indicates a "special train."

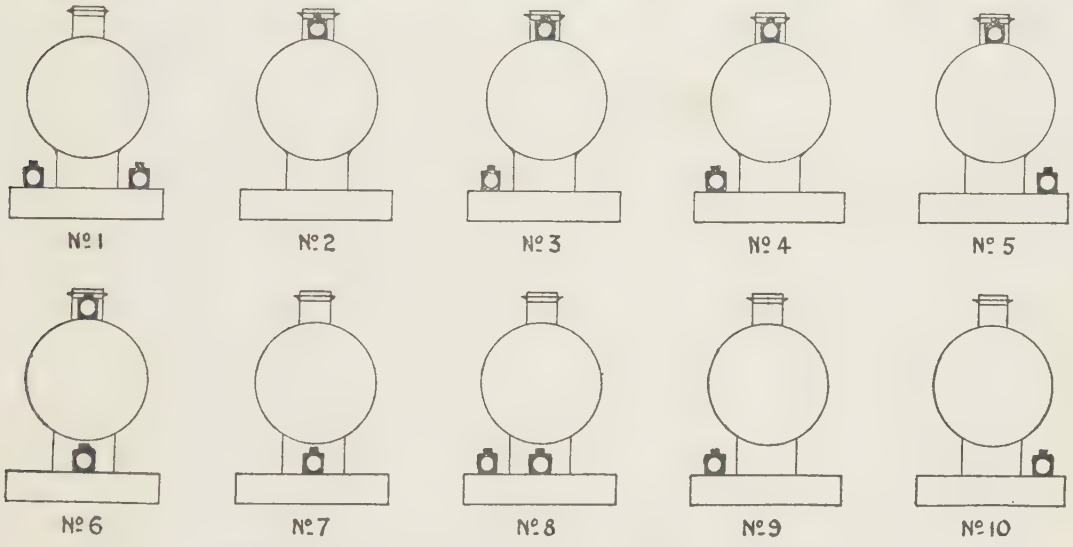
CLACTON & WALTON EXPRESS, LONDON & NORTH EASTERN RAILWAY
The " express passenger " head code is indicated with the white discs over each buffer.

the " class " of each train. There is, first of all, the familiar pair of lamps, one just over each buffer on the front of the engine ; this shows that the train is an " express passenger." Then there is the single headlamp, at the base of the chimney or just

THE " FLYING SCOTSMAN," LONDON & NORTH EASTERN RAILWAY
The engine is carrying " express passenger " headlamps over each buffer.

below; this indicates an "ordinary" or "stopping passenger" train.

So the list goes on, through the various kinds of goods trains, empty carriage trains, "light engines" (engines without any coaches behind them) and so on. There is not space to detail them all here, but the little series of diagrams shown on this page may help you to recognise the various kinds of trains in future. On the London and



STANDARD BRITISH CODE OF ENGINE HEADLAMPS

1. Express Passenger Train. 2. Ordinary (Stopping) Passenger Train. 3. Empty Passenger Train. 4. Express Fish, Fruit or other train carrying "Perishable" traffic in vehicles fitted with continuous brakes. 5. Express Goods Train carrying "Perishable" traffic in ordinary goods wagons, Class "A." 6. Express Goods or Cattle Train, Class "B." 7. Light Engine, or Engine with Brake-Van only. 8. Through Goods Train. 9. Through Goods Train making intermediate stops. 10. Ordinary Stopping Goods Train.

North Eastern Railway the headlamps are now being specially painted white, so that they may be seen at a distance.

The positions principally used for the lamps are four—at the base of the chimney, over each buffer and in the middle of the buffer-beam, just over the couplings. Some railways, however, have additional "lamp-irons." On the South Western section of the Southern Railway discs and lamps are carried on both sides of the

THE WEST COAST "SCOTSMAN" ON THE CALEDONIAN SECTION, L.M.S.R.
Notice the route indicator at the foot of the engine chimney.

boiler—or, really, on what is called the "smoke-box." You see these positions in use in the photograph at the beginning of this chapter, showing a Bournemouth express, which carries its three white discs in a triangle.

The late Caledonian Railway had a head-code of its own, quite different from the codes in use elsewhere. The lamps were not carried on the front of the engine, but on each side of the driver's cab, so that only two positions were available. But for route-indicating by day, each engine was provided with an indicator rather like the two hands of a clock, to be fixed in front of the chimney. The two hands or arms of the indicator could be set in any position, and by their particular angle indicated the route the train is to follow. In the picture on this page—of a West Coast Scotch express running between Glasgow and Carlisle—the route is indicated by setting the hands at "a quarter to three." But now that the Caledonian has become a part of the great London, Midland and Scottish

SMALLEST [illegible] R RAILWAY IN THE WORLD

system, this special code is being abandoned in favour of the " national " code of headlights.

Another matter that I might mention is the carrying of numbers on the front of engines. These usually indicate that the train concerned is a " special " train—that is to say, one that is not shown in the ordinary time-tables. In such cases, the train is given a number in the " weekly working notice," which tells the staffs of all the special arrangements for the week, and the engine carries a corresponding number, so that the train may be easily recognised by all the people concerned. The South Western section of the Southern Railway, however, now makes every engine carry the " number " of its train, as you can see in the photograph at the head of the chapter.

A Heavy Great Eastern Coal Train, L.N.E.R.

The three white discs indicate a " through mineral " train (since simplified to two, as No. 8, p. 59); the blue disc at the foot of the chimney shows it is a " special " working.

New Standard Sleeping Car, London, Midland & Scottish Railway

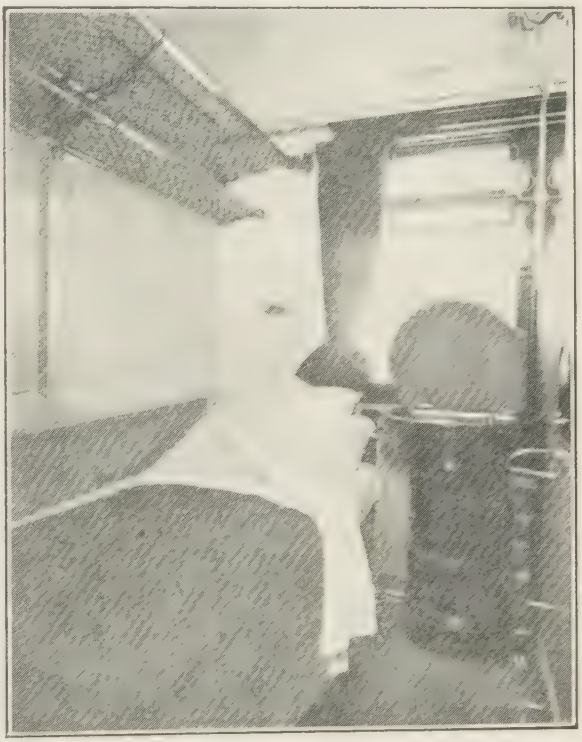
SLEEPING WHILE YOU TRAVEL

IT is only a small proportion of the journeys in this country that are long enough to make sleeping cars worth while. In fact, sleeping cars are only run between London and Scotland, as well as to the northern English cities, and then westwards to South Wales and the distant places of Devon and Cornwall. Business men in particular value a sleeping car, because it enables them to do a day's business, say, in London, then to go to bed in the train, and to wake up the next morning in Glasgow, for example, ready to do business up there, without having wasted a day on travelling.

Nothing could be more comfortable than one of our present-day " sleepers," such as the East Coast coach of which you see the inside opposite. It is divided into ten or eleven separate " bedrooms," each of them opening out on to the corridor. Space, of course, is very precious ; and after all the beds have been arranged crossways there is just about enough space left in each bedroom to turn round. Even then this coach, with its ten or eleven rooms, holding only the same number of people, weighs 45 tons or so, which readily explains why such heavy prices have to be charged for the use of a " berth."

Everything inside the compartments is beautifully fitted and arranged ; hot and cold water is laid on in each one ; electric lights that can be turned up full or burned with a dim light ; electric fans ; and hosts of other aids to comfort. At the end of the sleeping car is a compartment for an attendant, who looks after the wants of the occupants, and can supply them with tea and coffee and other light refreshments. Then every device making for smooth running and the deadening of noise has been used in building the car, very special attention being paid to the springs, and to interposing layers of rubber between the steel " frame " and the timber " body."

In other countries, where journeys have to be made which often mean living in the train for days together, sleeping accommodation has to be provided on a larger scale. Continental sleeping cars generally have two berths in each room, one above the other, which, of course, doubles the capacity of the car. On other railways, such as the well-known " P.L.M." of France, running from Paris down to the Riviera, besides the special sleeping-car trains, trains are run in which the ordinary compartments can be made into bedrooms at night by pulling out the seats till they meet in the middle, and turning them into beds.

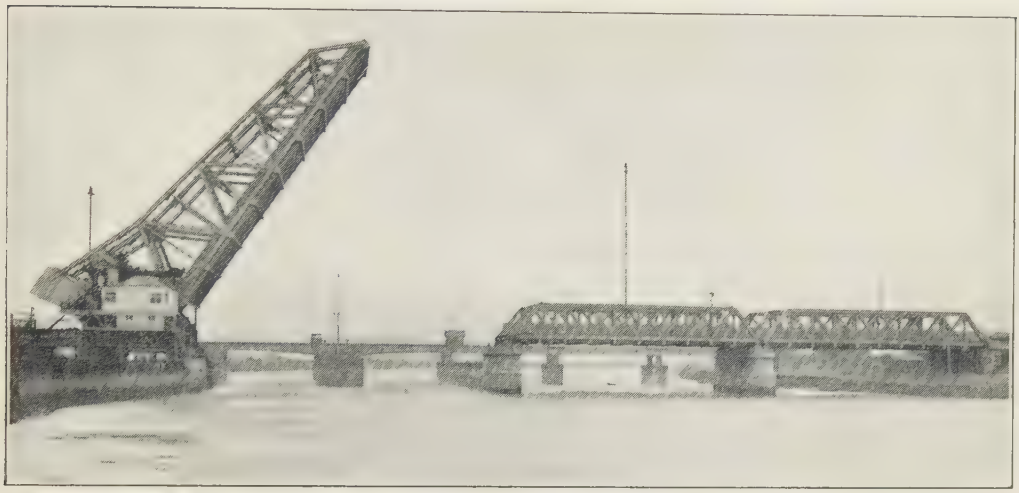


A Sleeping Berth on the Night " Scotsman," London & North Eastern Railway

In Canada and America,

where a journey across the continent may take a full week, it is quite customary to build big cars which are used as ordinary coaches in the daytime, and turned into sleeping cars at night. This picture of a Canadian Pacific Railway sleeping car shows the arrangement very clearly. On the right-hand side you see how the coach is arranged for day use ; and then, on the left-hand side, part of the roof has been let down to form a series of upper berths, and the seats have been pulled out to make the lower berths. You have to undress and get into bed behind the curtains. This is neither so comfortable nor so private as our English type of sleeping car, but it has the advantage of providing a bed at night-time for everybody on the train.

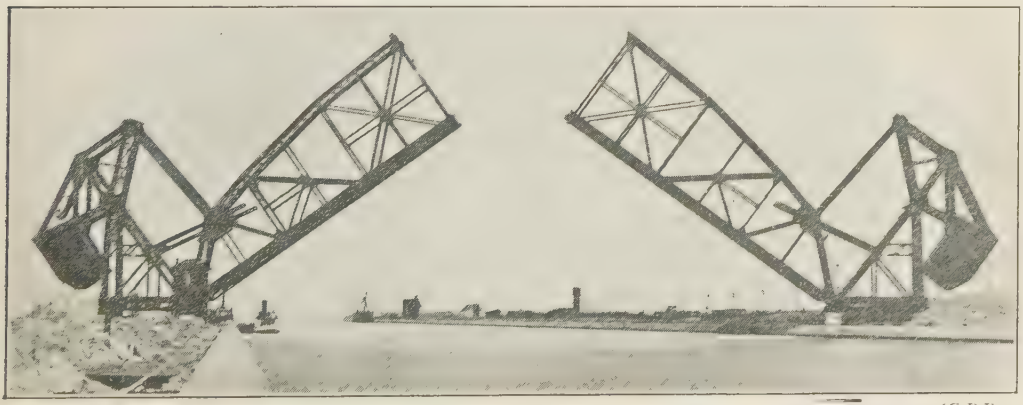
INTERIOR OF STANDARD "SLEEPER," CANADIAN PACIFIC RAILWAY
On the right are the seats as arranged for day use, and on the left the berths have been made up ready for the night.



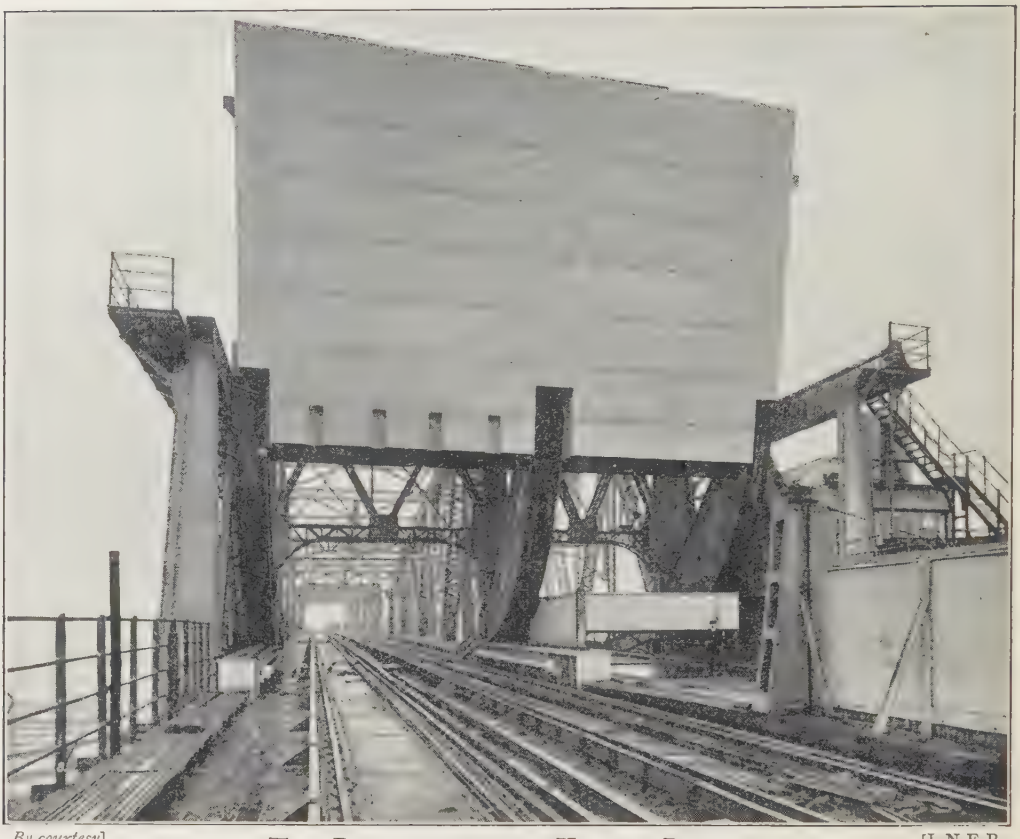
By courtesy] KEADBY BRIDGE OVER THE RIVER TRENT [L.N.E.R.

RAILWAY BRIDGES THAT OPEN

WHEN a railway crosses a river or a canal up which steamers pass, special arrangements must be made in order that the masts and funnels of the boats shall not be obstructed by the railway bridge. In some cases, like those of the Forth Bridge, the railway itself has been raised sufficiently high to clear the biggest boats that are likely to pass underneath. In other cases, where the interruption of railway traffic does not matter quite so much, a bridge



By courtesy] BASCULE BRIDGE AT SAULT STE. MARIE, CANADA [C.P.R.



By courtesy] THE BALANCE-WEIGHT, KEADBY BRIDGE [L.N.E.R.

is designed which can be opened, when required, to give a clear water passage.

Two kinds of opening bridges may be seen in the picture at the head of this chapter, which shows the busy North Lincolnshire line of the L.N.E.R. crossing the wide estuary of the River Trent at Keadby, between Doncaster and Grimsby. In the background is the old " swing-bridge," which has now been abandoned and broken up ; in the foreground is the new " rolling lift " bridge. The opening span of the former swings round about its centre, so making two water passages, one on each side of the centre tower ; but the rolling lift bridge, when open, stands right up on end, as you can see, making a water channel twice as wide as the old bridge.

The principle of the rolling lift bridge is clear in the photograph opposite, which shows the roller-gear on which the bridge moves, and the enormous steel balance-weight that balances the weight of the lifting span, so enabling the latter to be lifted easily. The bridge is shown open to the railway—and also to the main road that runs alongside—and closed to the river. Needless to say, very careful signalling arrangements have to be made to prevent trains from running on to the bridge when it is open to the river.

Of the two Canadian bridges illustrated, that at Sault Ste. Marie, on the Canadian Pacific Railway, is a " bascule " bridge, in which two lifting spans are employed, just like the Tower Bridge in London. The bridge of the Canadian National Railways at Prince George is arranged so that the whole of the short span in the foreground is lifted into the air when the bridge is open to the river, instead of being hinged at one end.

By courtesy] OPENING BRIDGE AT PRINCE GEORGE, BRITISH COLUMBIA [C.N.R.

Photo] [F. E. Mackay

THE "SOUTHERN BELLE," SOUTHERN RAILWAY

WORLD-FAMOUS EXPRESS TRAINS

ONE of the most famous of our British trains is the "Flying Scotsman," which leaves King's Cross terminus in London every morning at ten o'clock for Edinburgh, Glasgow, Perth and Aberdeen. Since 1862 it has left at exactly the same time, which in itself is a record. Less than thirty years ago there were no corridor carriages or dining cars, and a halt of twenty minutes was made at York while passengers bolted a very hasty lunch. To-day passengers enjoy every luxury that it is possible to provide in two magnificent trains which were put into service in 1924; meals and refreshments are obtainable throughout the journey, and all the cooking is done by electricity.

Because it hugs the East Coast for a great part of the distance, the route followed by the "Flying Scotsman" is known as the "East Coast Route." On the other side of the country the main line of the London, Midland and Scottish Railway to Scotland is known as the "West Coast Route," and a West Coast day Scotch express is seen in another coloured illustration, passing Tebay at full speed. Tebay is situated in the wilds of the Westmorland hills,

Photo] [F. E. Mackay

THE LINE OVER WHICH BRITAIN'S HEAVIEST EXPRESS TRAINS ARE WORKED
LEEDS AND BRADFORD EXPRESS, L.N.E.R.

and is just at the foot of the steep incline leading to Shap Summit, 915 feet above sea-level. When the express trains are very heavy, it is necessary for them to stop at Tebay, in order that they may get the assistance of a " banking engine," which will help them in their climb to the summit by giving a friendly push behind.

Photo] [F. E. Mackay

THE FASTEST TRAIN IN BRITAIN
CHELTENHAM TO PADDINGTON EXPRESS, G.W.R.

Photo] [Loco. Publishing Co.

THE LONGEST NON-STOP RUN IN THE WORLD
"CORNISH RIVIERA" EXPRESS NEARING EXETER, G.W.R.

The Great Western Railway holds most of the records for speed in this country. The 3.45 p.m. train in the afternoon from Swindon to Paddington is allowed only 75 minutes in which to cover a distance of 77¼ miles, and the 11.15 a.m. and 1.15 p.m. from Paddington to Bristol, also, are booked to "slip" carriages at Bath, 107 miles away, in 105 minutes after leaving London. All these trains have therefore to keep up an average speed of well over 60 miles an hour, and when due allowance has been made for getting up speed, and slowing down again, it means that many miles must be covered at over 70 miles an hour, if time is to be kept. Credit for the highest speed ever recorded in this country behind a locomotive also belongs to the Great Western Railway, which in racing the Transatlantic mails

from Plymouth to London in 1904, attained 102½ miles an hour down a gradient near Taunton, and kept up a speed of round about 80 miles an hour all the way from Swindon to Paddington.

When it comes to long runs without a stop, the Great Western Railway again heads the list. The famous " Cornish Riviera Limited " express, leaving Paddington at half-past ten in the morning, does not stop anywhere short of Plymouth, 226 miles away from London ; although it does, without stopping, set down passengers by slip coaches at Westbury, Taunton and Exeter. This is the longest non-stop run in the whole world, by a wide margin. In the summer the Great Western does the 200 miles between Paddington and Torquay in both directions without stopping, and all the year round there are expresses which run the 174 miles between London and Exeter, both ways non-stop, in the fast time of three hours, averaging 58 miles an hour.

The London, Midland and Scottish Railway is also responsible for some lengthy non-stopping runs. The evening " diner," leaving

Photo] [F. E. Mackay

AMONG THE WESTMORLAND FELLS
WEST COAST SCOTCH EXPRESS NEAR TEBAY, L.M.S.R.

Photo] [J. M. Robbins

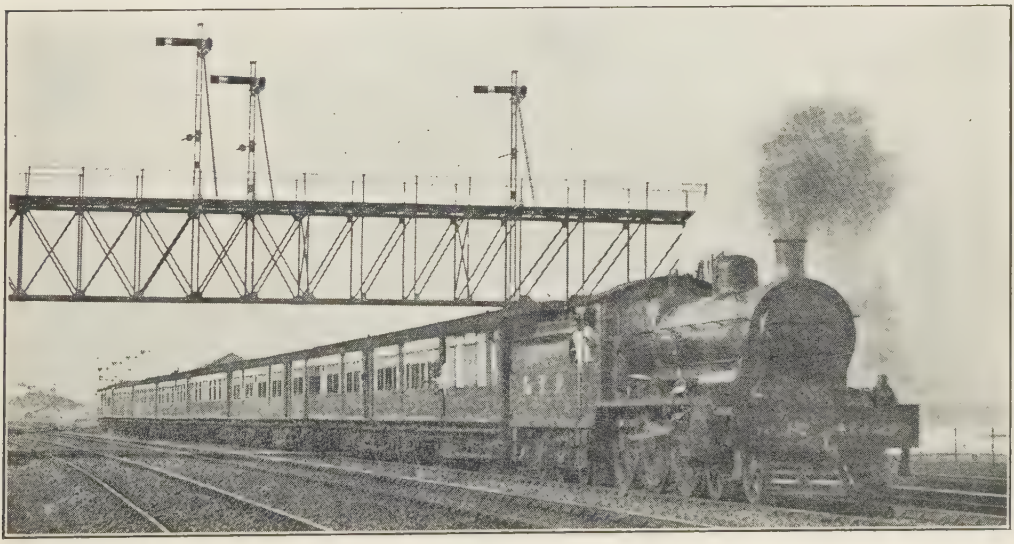
BELFAST TO DUBLIN EXPRESS
GREAT NORTHERN RAILWAY OF IRELAND

Euston at 5.55 p.m., does not halt until it reaches Mossley Hill Station at Liverpool—a distance of 190 miles. On the London and North Eastern Railway the all-the-year-round non-stop record is held by the famous "Edinburgh Pullman," which bridges the 199 miles between King's Cross and Harrogate, down and up, without any halt on the way intermediately. Some very fast running is also performed over certain portions of the London and North Eastern system, especially along the magnificent racing stretch—both straight and level—from Darlington to York. For many years past an express has been booked to cover the distance of a little over 44 miles in 43 minutes, start-to-stop, and until the institution of the Great Western 75-minute run from Swindon to Paddington this was the fastest daily journey in the British Empire.

On the Great Central section of the same railway, again, there are such timings as 65 minutes for a little over 65 miles from Aylesbury to Leicester ; and then the down newspaper express, leaving Marylebone in the small hours of the morning, makes three striking " sprints " in succession—from Brackley to Rugby, 24 miles in 24 minutes ; Rugby to Leicester, 20 miles in 20 minutes ; and Leicester to Arkwright Street Station at Nottingham, 22½ miles in 22 minutes. When you realise that each of these is a run from dead start to dead stop, over a sharply undulating road, you will understand why a whole string of eighty-miles-an-hour maximum speeds is necessary if the precious papers are to arrive on time, as they invariably do.

The most famous train on the Southern Railway is probably the luxurious " Southern Belle " express, composed entirely of Pullman cars, which every day makes four journeys of 51 miles between Victoria and Brighton, each in the even hour, though the recently instituted " Atlantic Coast Express," serving from Waterloo all the well-known coast resorts in North Devon, is likely soon to rival the " Belle " in popularity.

On the Continent, the Northern Railway of France has the reputation of running the fastest trains in Europe. The morning and midday boat expresses from Paris to Calais are only allowed 195 minutes to run the 184 miles, and this includes a stop of 3 minutes at Abbeville for water (because there are no track-troughs), and also a tremendous climb from the outskirts of Boulogne up to the summit at Caffiers, which brings down the speed considerably. Only 110 minutes are allowed for the 109 miles from Paris to Abbeville. One of the Boulogne boat trains has to cover the 141½ miles from Paris to Etaples in 142 minutes. The expresses running northwards to



Bombay to Poona Express, Great Indian Peninsula Railway

Photo] [W. H. . Kelland

ENGLISH BOAT EXPRESS, NORTHERN RAILWAY OF FRANCE

Brussels and Berlin make equally fast times, such as 93 minutes from Paris to get through St. Quentin, 95 miles away.

Most of the best and fastest trains on the Continent are called " Trains de Luxe," and consist of dining and sleeping cars only. Some of them run for several days and nights at a stretch, such as the Orient Express, which travels right across Europe from Calais to Constantinople. Another of these trains—the Côte d'Azur Rapide—runs from Calais down to the Riviera, and from the use of magnificent new sleeping cars (built, by the way, in England), painted royal blue, has come to be christened the " Blue Train."

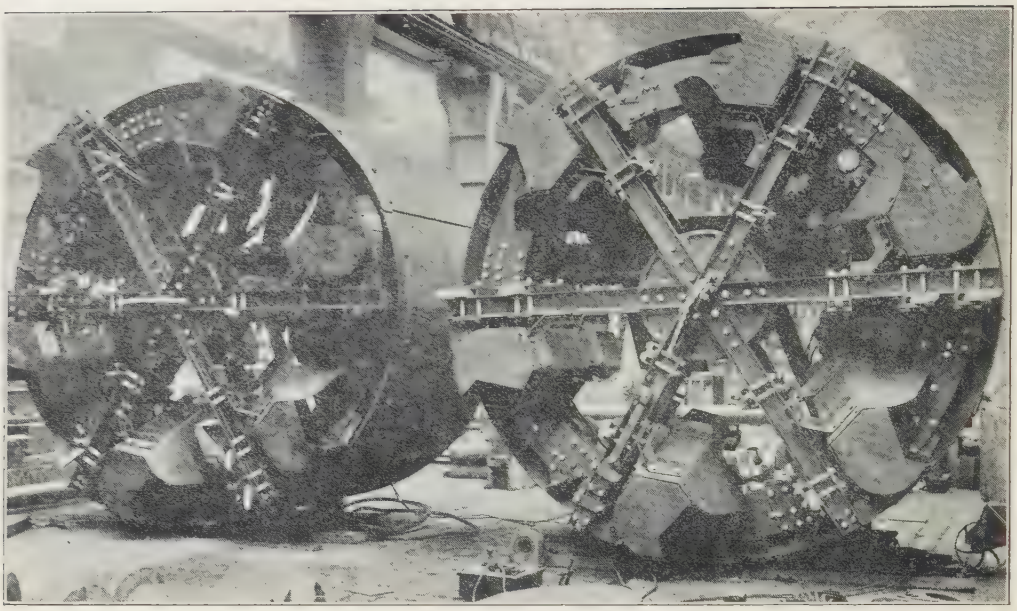
America used to hold the " blue riband " for railway speed. It was possible before the war for business men to make their morning and evening journeys between the city of Philadelphia and the popular seaside resort of Atlantic City in the even hour. But as this involved crossing in a ferry a wide river at the Philadelphia end,

for which ten minutes were necessary, it left to the locomotives of the Philadelphia and Reading Railroad the task of covering the remaining $55\frac{1}{2}$ miles of the journey in 50 minutes, start-to-stop. On one occasion the journey was actually completed in 43 minutes. But the loads of the expresses are so much heavier to-day that it has been found necessary to extend the fastest time to 55 minutes.

American railway speeds in general are not so high as our speeds over here. But the Americans have some remarkable long-distance trains, nearly all of which carry fancy names. There is, for example, the " Twentieth Century Limited " of the New York Central Lines, and the " Broadway Limited " of the Pennsylvania, both linking the great cities of New York and Chicago. Other names, which abound in hundreds, such as " Buckeye Limited," " Katy Flier," " New Yorker," " Wolverine," and so on, sound strange to us, but are used universally in the United States. The chief of these expresses are hotels on wheels, equipped with sleeping, dining and drawing-room cars, libraries, wireless, and even a barber !

Photo] {Loco. Publishing Co.

AN AMERICAN TRANSCONTINENTAL EXPRESS



ROTARY EXCAVATORS USED IN PRESENT-DAY TUNNELLING

TUNNELS

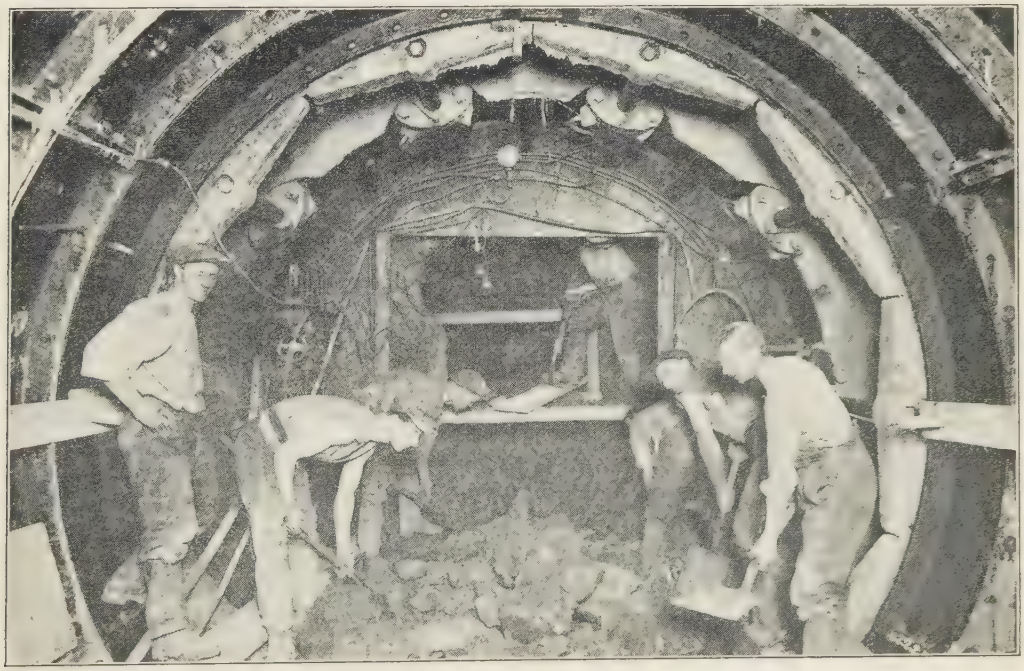
(Photos by courtesy of London Underground Railways, except as otherwise noted)

THE two formidable appliances, seen in the picture at the head of this chapter, are a reminder of the heavy cost of boring railway tunnels. They are known as Price Rotary Excavators, and have greatly speeded up the work of boring our tubes. Each of the six big spokes, like those of a wheel, carries " teeth," and the whole of the wheel is arranged to rotate inside its circular shield, which is like the barrel of a drum. Not only so, but there is also gearing inside the drum which drives the wheel slowly forwards. As it advances, the cutting teeth gradually slice away the earth in front of them, and deliver it into chutes which pass it to the back of the excavator, and from there it is loaded into wagons to be run away out of the tunnel. With this remarkable tool it is possible to drive the tunnels forward from twenty to twenty-five feet a day.

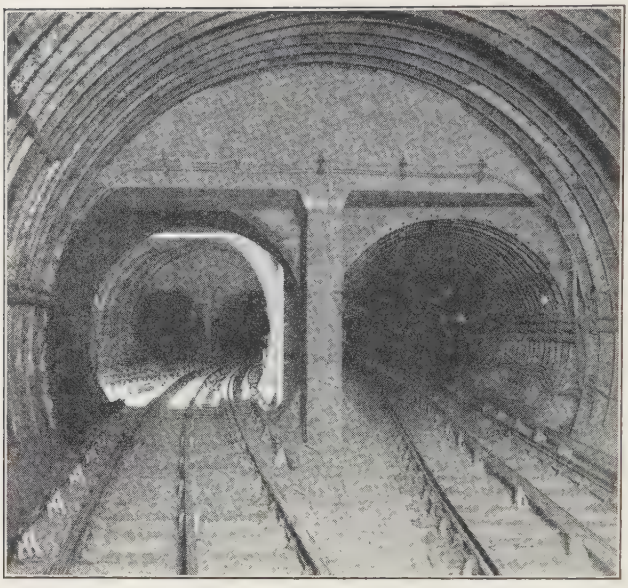
This excavator was a development of the Greathead Shield, in

the next picture, which also represented a great advance on the previous methods of boring tunnels. The shield encases just one big circular cutting edge, which is driven very slowly forward by hydraulic rams, while the material inside is shovelled away into wagons by the navvies. The tunnel itself is then actually built up inside the shield—just like two lengths of a telescope—and the narrow space that has been left between the tunnel and the outside of the drum is filled in with cement, which is run in under pressure by the process known as "grouting," and sets solid. Tube tunnels are not built of brick or stone, but "segments" of cast iron are used, about an inch in thickness, and fitting together in such a way as to make the complete circle of the tube.

The most remarkable of all our tube lay-outs is probably the recently-completed junction at Camden Town, which figures in the next pictures, on page 78. Originally, the Charing Cross, Euston



Inside a Greathead Tunnelling Shield



THE TUBE JUNCTIONS AT CAMDEN TOWN

(which have themselves been extended to Edgware) and the Highgate tubes. The extraordinary complication of tunnelling that this has involved is very clear in this diagram; it is in order that no two trains in any direction shall have to cross each other's paths on the level.

The dotted lines and the little arrows on the diagram show how ingeniously the junctions have been planned. In the photograph above you can just see, on the extreme left-hand side, the tunnel from Charing Cross to Highgate; the tunnel next to it is bringing the line from Moorgate, and the crossover and Hampstead tube came up in the two tunnels at the bottom left-hand side of the diagram, and branched into two directions, the top left-hand tubes going off to Golder's Green, and the top right-hand ones to Highgate. Now the City and South London tubes have been extended from Euston to join up with both the Golder's Green tubes

A DIAGRAM OF THE TUBE LAY-OUT AT CAMDEN TOWN

going away to the left carries the trains from Moorgate to Highgate ; then in the foreground you have the line from Moorgate to Edgware, on the left, joining that from Charing Cross to Edgware, on the right, Edgware being behind you. With this remarkable planning it is possible to run 40 trains per hour from each branch, or no less than 160 trains all over the junction in a single hour.

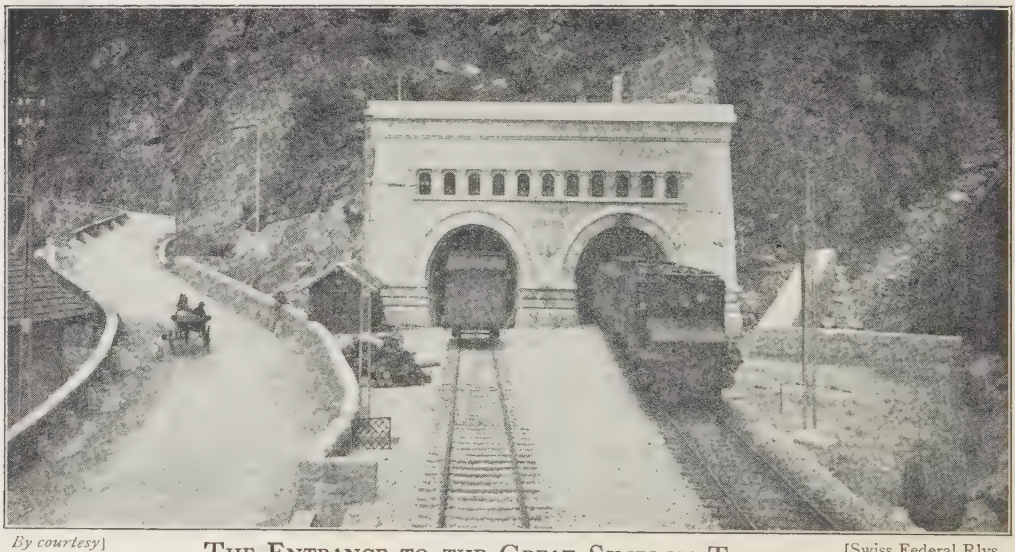
In not all of our tunnels has so simple a material as ordinary soil to be dealt with in the boring. In the North of England the mountain range of the Pennines cuts the country in two, from north to south, and every main line from east to west has to get through, in almost every case by tunnelling. But here it has been necessary to deal with rock, and this means blasting instead of excavation. The late North Western line cuts through, on its way from Leeds to Manchester, by means of Standedge Tunnel, three parallel bores, each just over 3 miles long ; the Great Central line from Sheffield to Manchester follows the two parallel bores of Woodhead Tunnel, also

By courtesy] SOUTH WALES EXPRESS LEAVING THE SEVERN TUNNEL [G.W.R.

3 miles in length; the Midland Sheffield and Manchester line threads three long tunnels—Totley, $3\frac{1}{4}$ miles; Cowburn, just over 2 miles; and Disley, $2\frac{3}{8}$ miles.

The longest of our British main line tunnels is that by which the South Wales main line of the Great Western is carried under the estuary of the Severn, this being nearly $4\frac{1}{2}$ miles in length. Enormous difficulties were encountered in its construction, water breaking into the workings more than once, so that the ultimate cost was some two millions sterling of money.

In such countries as Switzerland, of course, there are far longer tunnels, under the vast mountain masses of the Alps. The St. Gotthard, the Mt. Cenis, and the Loetschberg Tunnels, are all from 8 to 9 miles long; but they are completely outstripped by the Simplon, whose two parallel bores, through the solid rock under the Simplon Pass, are no less than $12\frac{1}{4}$ miles long, and are the longest railway tunnels in the world. Three millions of money were needed to complete this vital link between Switzerland and Italy, and eight years were occupied in its construction.



By courtesy] THE ENTRANCE TO THE GREAT SIMPLON TUNNEL [Swiss Federal Rlys.

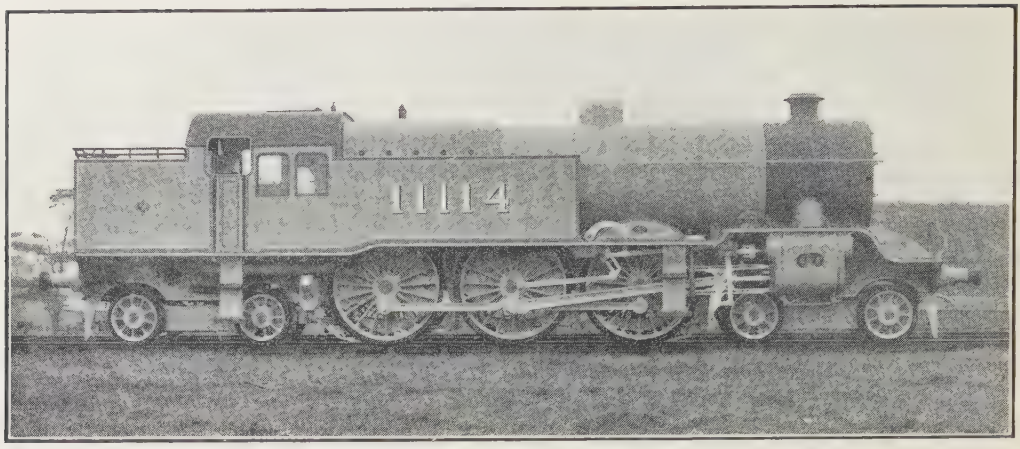
4-6-2 ("Pacific" Type) Express Engine, "Flying Scotsman," London and North Eastern Railway

LOCOMOTIVES AND THEIR WORK

EVEN in these days of electric locomotives, of motor-cars and of aeroplanes, nothing in connection with travel is quite so fascinating as the steam locomotive. There is something peculiarly human about the locomotive, indeed, which is not shared by any other piece of machinery.

First, we can divide locomotives up into two main classes—those with tenders and those without. The former carry their supplies of coal and water in a separate vehicle, or tender, coupled to the engine; in the latter, called "tank" engines, the food and drink are carried by the engine itself, and a tender is dispensed with.

It is simply a question of length of journey. Main line engines have to travel long distances without replenishing their supply of coal, although, as we have seen already, water can be picked up from time to time without stopping by means of the track-troughs. The big eight-wheeled tenders of the London and North Eastern "Pacific" engines, one of which appears at the head of this chapter, hold no less than 8 tons of coal—enough to run the 376 miles from

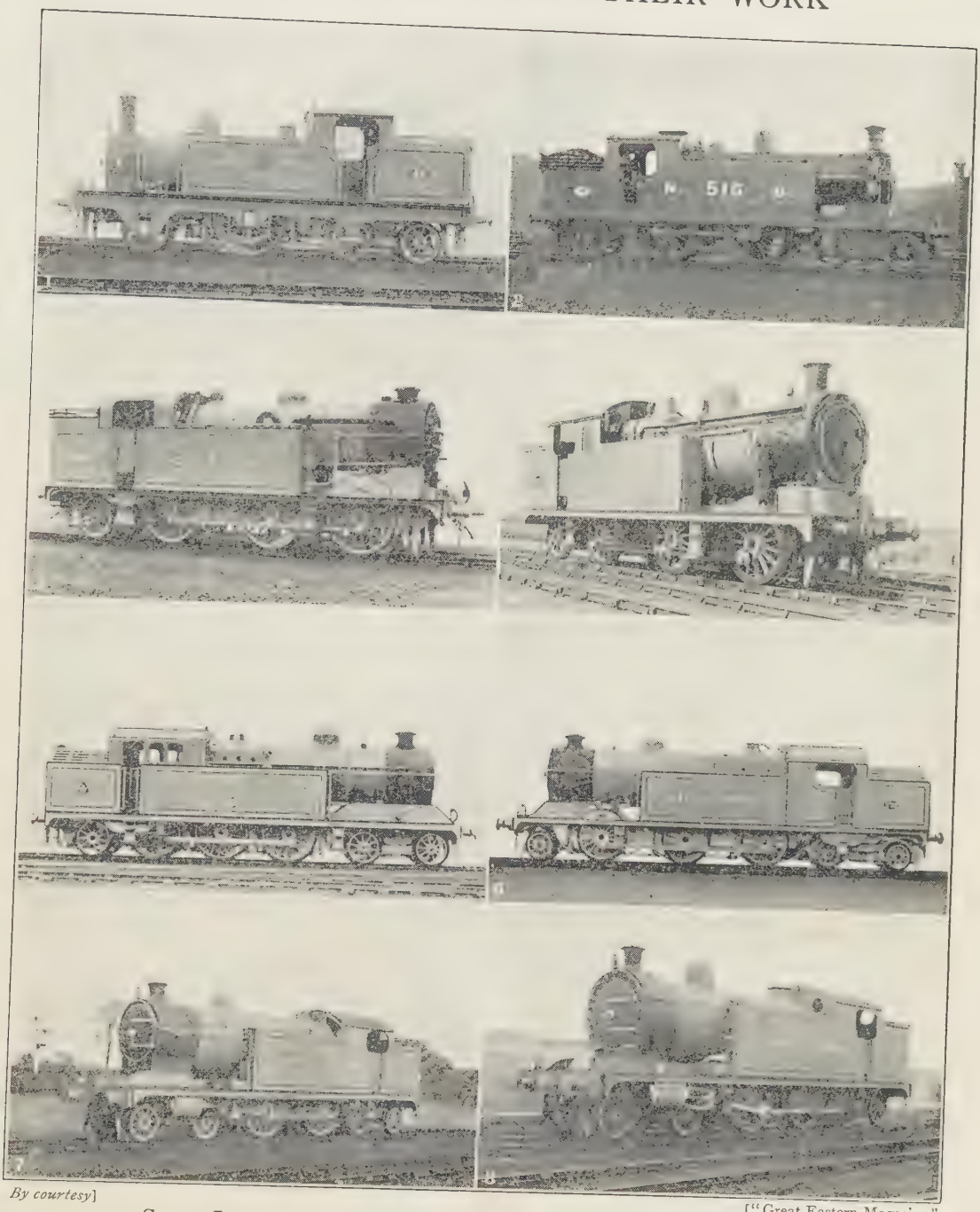


4-6-4 ("Baltic" Type) Express Tank Engine, L.M.S. Railway

London to York and back—when they are full; while the tender of the enormous Canadian National engine on page 90 can accommodate 17 tons, as these engines make continuous runs of 333 miles from Montreal to Toronto without being changed. The tender in this case is carried on twelve wheels.

The principal part of the tender space, however, is occupied by the water tank, and a modern British tender will hold up to four or five thousand gallons of water. The Canadian tender I have just referred to holds ten thousand gallons; but there are no track-troughs on the Canadian railways, and in addition this is a much bigger and more powerful engine than anything we should have room to build on the railways of this country.

But tank engines are intended for short journeys, where such large quantities of coal and water are quite unnecessary. So, in the majority of tank engines, water is carried in those large flat-sided tanks that you see along both sides of the boiler, and which give a tank engine so characteristic an appearance; these tanks can hold a couple of thousand gallons or so. Coal is carried in the bunker at the rear end of the engine, which will take from 2 to 4 tons. Sometimes, in the case of shunting engines, the water tank is perched



By courtesy] ["Great Eastern Magazine"

SOME LONDON & NORTH EASTERN RAILWAY TANK ENGINES

1. 2-2-4 N.E. Tank for Special Trains.
2. 4-4-2 Passenger Tank, N.B. Section.
3. 0-6-2 Suburban Tank, G.N. Section.
4. 0-6-2 Suburban Tank, G.E. Section.
5. 4-6-2 Suburban Tank, G.C. Section.
6. 2-6-4 G.C. Tank for Mineral Trains.
7. 4-4-4 Passenger Tank, N.E. Section.
8. 4-6-2 N.E. Tank for Mineral Trains.

Photo] [F. E. Mackay

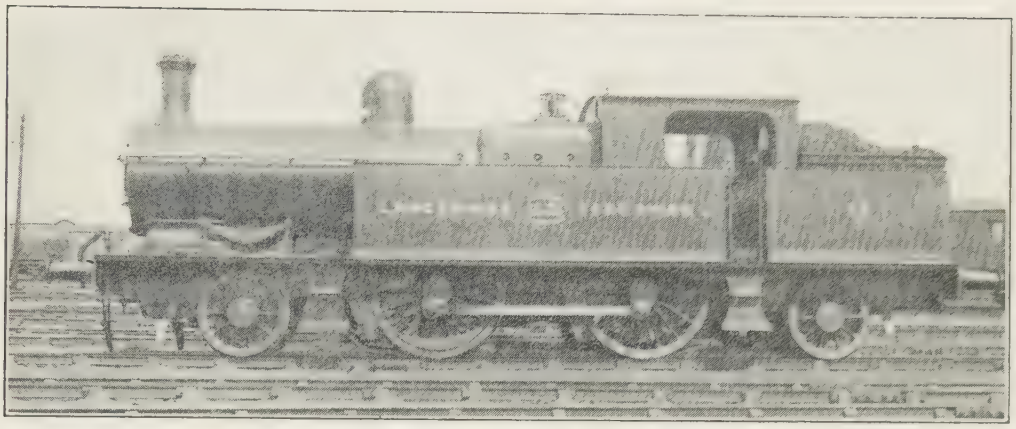
ONE OF THE BIG BRIGHTON 4-6-4 EXPRESS TANK ENGINES LEAVING VICTORIA, SOUTHERN RAILWAY

up on the top of the boiler, and the engine becomes a " saddle tank " instead of a " side tank." But side tank engines are much the more common.

The chief use of tank locomotives is on short-distance suburban train services, where it would be wasteful to haul about a great heavy tender all the time. Not only so, but for these short journeys an engine is needed which does not have to be turned round on a turntable at the end of each run. Any locomotive can run just as easily in a backwards direction, of course, as it can forwards ; but it is not advisable, in the case of a tender engine, for the engine to be pushing the tender in front of it when running at speed. Besides that, the look-out in front for the driver over a big tender piled high with coal is a very poor one. But the tank engine is specially designed with a good look-out both front and rear, and is

A 300-ton American "Mallet" Type Freight Engine.

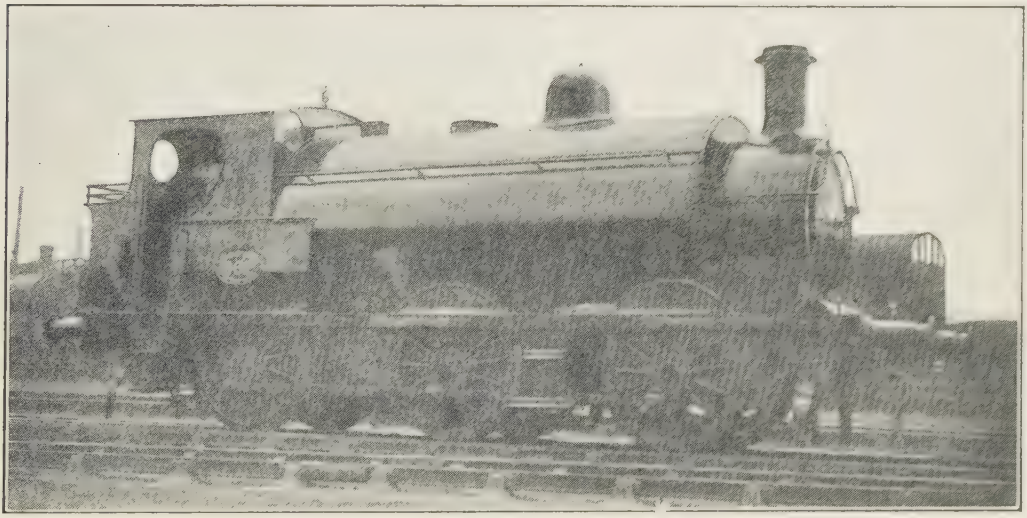
Pennsylvania Railroad.



A "Side" Tank Engine, L.M.S. Railway

the handiest of machines for running short-distance suburban trains, with quick turns round at both ends of the journey.

Of late years tank locomotives have come quite into favour for really fast express running over short distances. Here again there is no reason why great heavy tenders should be hauled about on such short runs, for example, as the 51 miles of the Southern Railway expresses between Victoria and Brighton. So for these services



A "Saddle" Tank Engine, L.M.S. Railway

very powerful "express tank" engines have been built by the Brighton line. These are really express engines in every respect other than having a separate tender; and frequently touch such high speeds as 75 miles an hour and over when running to and from Brighton on the "Southern Belle" and other 60-minute trains.

The next thing that we have to notice is the size and arrangement of the wheels of the engine. This is a matter of no little importance; it governs the work that the locomotive will be called upon to do when in service. Now, in order to understand this subject thoroughly, let us think of some particular type of engine: suppose we take the big London and North Eastern "Pacific" express engine that is illustrated at the head of this chapter.

Leaving the tender out of account, you will notice that the engine is carried on wheels of different sizes. There are, if you look, three pairs of big wheels in the middle, pinned together by a long rod that goes flying round with them when the engine is in motion—the "business" wheels that do the real work of moving the engine and

[Photo] ONE OF THE OLD MIDLAND "SINGLE-DRIVERS" AT WORK [F. E. Mackay

"Garratt" Banking Engine, L.N.E.R. (Type 2-8-0+0-8-2)
This engine is used to push coal trains up a steep incline near Barnsley.

train. And then, in front of them and behind them, there are smaller wheels which we may call "idle" wheels, because their work is simply that of helping to carry the engine, and to distribute its great weight nicely and evenly over the track.

The two pairs of wheels in front are mounted on a small truck, called a "bogie"; by means of a big pivot this carries the leading end of the engine, and enables it to swing smoothly and easily round the curves in the track, especially at high speeds. And the extra pair of wheels at the back end, under the driver's cab, allows the "firebox"—that vital part of the boiler that contains the engine fire—to be developed in size and improved in shape.

Now why is it necessary to have three pairs of driving wheels all coupled together? The earliest express engines had one very large pair of driving wheels only, and so earned the name of "single-drivers." It is needful for you to realise, at this point, that the engine boiler might be able to raise very large quantities of steam, and the engine cylinders to develop enormous power; but unless the driving wheels had sufficient grip on the rails, all the power developed would be valueless. The driving wheels would simply slip round on the rails and do no work.

"Caerphilly Castle," Great Western Railway

4-Cylinder Lancashire & Yorkshire Type, L.M.S. Railway

2-Cylinder "King Arthur" Type, Southern Railway

Some Present-Day 4-6-0 Express Engines

The amount of grip, or " adhesion," as it is called, depends on the weight that comes down upon the driving wheels, which, of course, bear their share of the weight of the engine. In fact, their share is really increased out of proportion, in order that as much of the weight of the engine as possible shall be available for increasing this grip. But then, on the other hand, a line must be drawn somewhere, or else you might bring so heavy a weight on one pair of wheels that the track and the bridges under the line would not stand it.

And so, as you can easily see, when trains grew gradually heavier —as they are doing all the time with the introduction of dining cars, and corridors, and more comfortable coaches, let alone the greater number of people travelling—the weight on one pair of driving wheels was no longer sufficient. Twenty tons on one pair of wheels is as much as we dare allow, although our American friends take rather greater risks, and go up to 30 tons on a pair of wheels. So what was done was simply to fit the engine with another pair of driving wheels of equal size, and to couple the two together with the " coupling-rods " that you see in all these pictures. This, in effect, made the two pairs of wheels act as one, and doubled the " adhesion weight " of the engine.

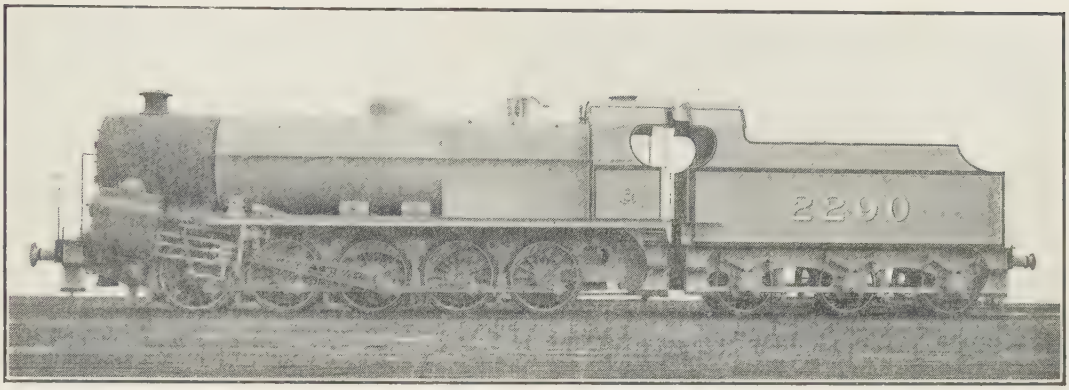
From the " four-wheels-coupled," or, for short, " four-coupled," engine we have gone on by degrees to six-coupled, eight-coupled and even ten-coupled engines, while there have been cases abroad where as many as six pairs of driving wheels have been coupled, making a twelve-coupled engine. For passenger work, four-coupled or six-coupled wheels are generally considered sufficient, as beyond that the coupling-rods begin to be a hindrance to high speed.

But in other countries, where heavy express trains have often to be worked over tremendously steep gradients, eight-coupled engines are quite often employed for passenger trains. The enormous Canadian National Railway engine illustrated on page 90 is a case

in point; this has to handle trains up to fifteen heavy all-steel coaches, weighing as much as 1000 tons, whereas in this country 400 to 500 tons, or a little over, is the outside weight for an express.

It is of interest to note here that the Canadian National engine, which is claimed to be the most powerful passenger locomotive in the world, weighs with its tender 259 tons in working order, as compared with the 150 tons of our heaviest engine—the London and North Eastern "Pacific." Out of the engine weight, 101 tons are available for "grip," against 60 tons in the English engine. But in Canada and America the railway builders have left some 3 feet more above their tracks than we have, and proportionate width too, which

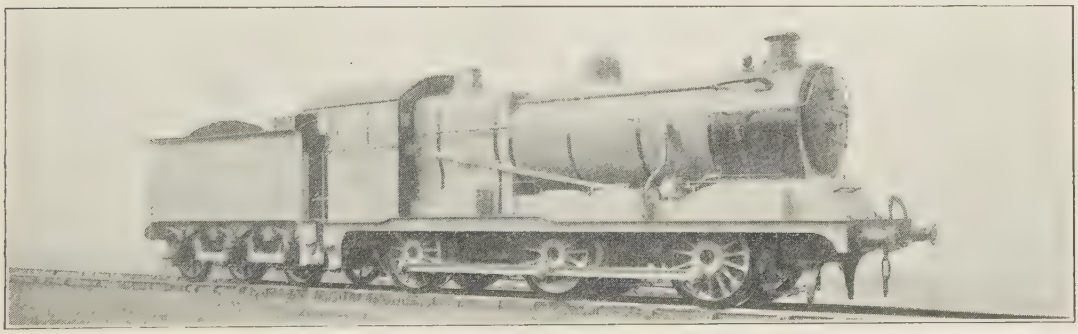
THE MOST POWERFUL PASSENGER ENGINE IN THE WORLD
NEW 4-8-2 ("MOUNTAIN" TYPE) LOCOMOTIVE, CANADIAN NATIONAL RAILWAYS



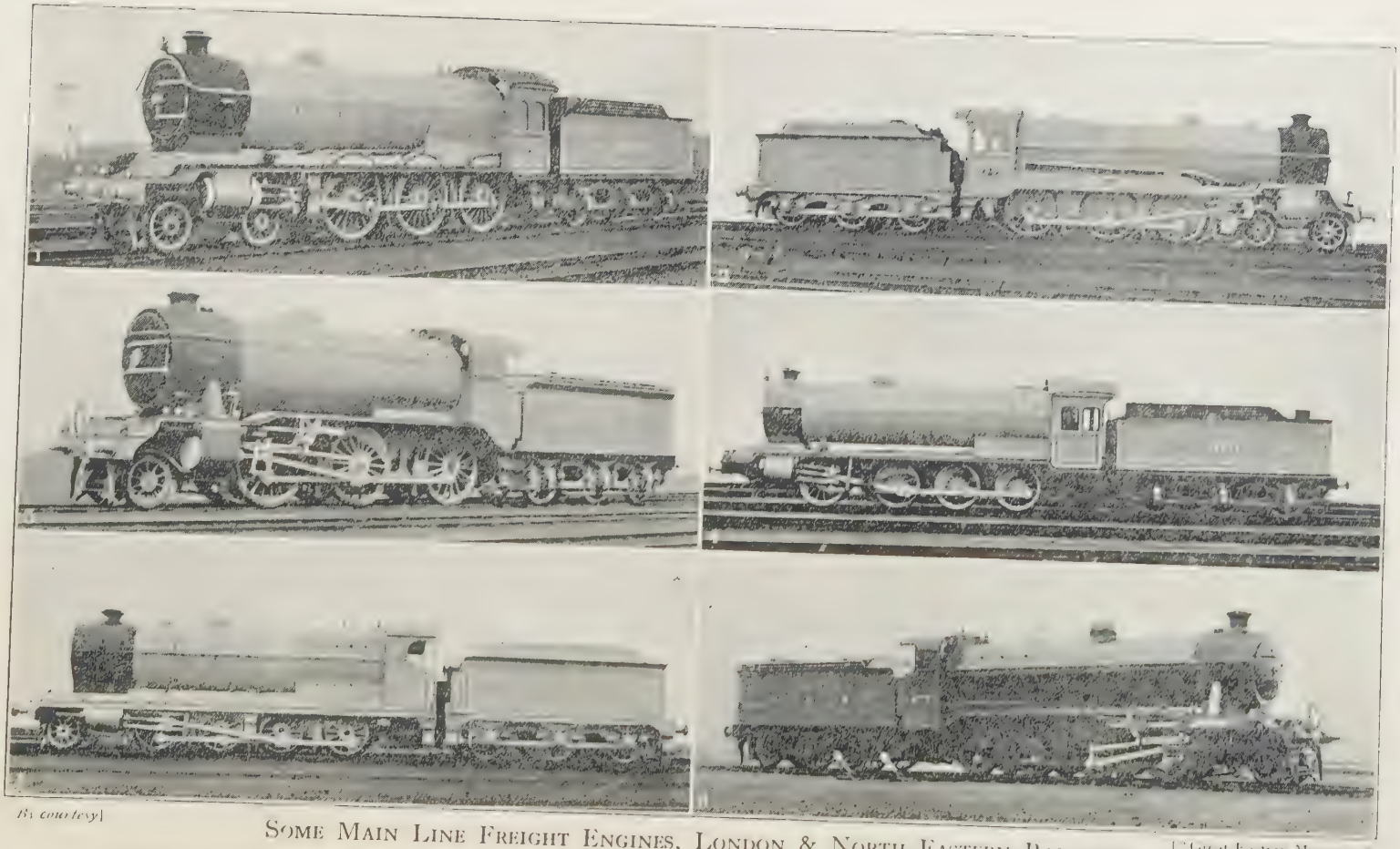
MIDLAND 0-10-0 ("DECAPOD" TYPE) BANKING ENGINE, L.M.S. RAILWAY

explains why they are able to build such enormous engines, although the gauge, or the distance between the rails, is just the same as in this country.

In the case of goods and mineral engines, which are not required to run at any great speed, no "bogie" is required, and very often no "idle" wheels are used at all, as with both the engines on this page. So all the wheels of such engines are driving wheels, and the whole of the engine weight is available for grip, or adhesion. Goods engines never have less than six wheels coupled, and very frequently eight-coupled wheels are used. There is only one ten-coupled engine in this country, and that is the tremendously powerful Midland engine used by the London, Midland and Scottish Railway for



0-6-0 TYPE GOODS ENGINE, GREAT EASTERN SECTION OF L.N.E.R.



[By courtesy] [The Great Eastern Magazine

SOME MAIN LINE FREIGHT ENGINES, LONDON & NORTH EASTERN RAILWAY

1. 3-cylinder 4-6-0 Express Goods Engine, N.E. Section.
2. 4-cylinder 4-6-0 Express Goods Engine, G.C. Section.
3. 3-cylinder " Mogul " Express Type, G.N. Section.
4. 3-cylinder 0-8-0 Mineral Engine, N.E. Section.
5. 2-cylinder " Consolidation " Mineral Engine, G.C. Section.
6. 3-cylinder " Consolidation " Mineral Engine, G.N. Section.

INSIDE A RESTAURANT CAR KITCHEN ON THE L.M.S. RAILWAY.

pushing West of England trains up the steep Lickey incline, from Bromsgrove to Blackwell, near Birmingham, shown on page 91.

The work that the engine is designed to do also governs the size of the driving wheels. Big wheels mean higher speeds and less pulling power, generally speaking, and small wheels give power at the expense of speed. The old " single-drivers," like the Midland type (see page 86), had driving wheels between 7 feet 6 inches and 8 feet in diameter. Modern express engines have driving wheels usually about a foot less in diameter than this. Goods engines are content with 5-feet driving wheels, or thereabouts.

And now just a word as to how we describe engines by numbers. By the use of certain numbers, based on the arrangements of the wheels, we are able to describe an engine in such a way as to know what type it is, and, with fair accuracy, for what work it is intended. Let us take that London and North Eastern " Pacific " again as our example.

Starting from the chimney end, we see that there are four " idle," or carrying wheels in front ; so we write down the figure " 4." Then there follow the six big driving wheels, three on either side ; to indicate these we add a " 6." Last of all, there is the single pair of wheels under the rear end of the engine ; this gives us a final " 2." The engine is therefore of the " 4-6-2 " type. The tender is not reckoned.

The middle figure of the notation always indicates the driving wheels ; and the figures to left and right the idle wheels at the front and back of the engine respectively. If there are no carrying wheels at all at front or rear, we must write down the figure " 0 " to make this clear ; " 0-6-0," for example, indicates one of the commonest types of goods engine in this country, such as the one illustrated at the bottom of page 91.

Some very frequently used nicknames have become associated

Photo] [Loco Publishing Company

"ATLANTIC" EXPRESS ENGINE, SOUTHERN RAILWAY, BRIGHTON SECTION

with certain arrangements of wheels. Most of them have come over to us from America. For example, the first 4-4-2 express engines on record ran between Camden City at Philadelphia and the favourite seaside resort of Atlantic City; so they were dubbed "Atlantics," and the name has stuck to 4-4-2 engines ever since. Similarly the 4-6-2 arrangement of wheels is known as the "Pacific," and the 4-6-4 as the "Baltic."

The monstrous Canadian National engine, to which I have referred several times, is of the 4-8-2, or "Mountain" type. Then there are freight, or goods engines, of the "Mogul" (2-6-0) and "Consolidation" (2-8-0) classes; you will see very large numbers of both on the Great Western Railway. The "Moguls" are usually looked upon as half goods and half passenger engines, and have fair-

sized driving wheels, up to 5 feet 8 inches or so in diameter ; so they are used to work either express goods trains or passenger trains other than the fast expresses. The commonest British type for working goods trains is the familiar 0-6-0.

Of express passenger engines in this country there are hundreds and hundreds of the 4-4-0 type ; in fact, the expresses of the Midland Division of the L.M.S. Railway are worked by nothing else. Up the East Coast main lines of the London and North Eastern Railway you find many 4-4-2, or "Atlantic" express engines, and these are now giving place to the huge "Pacific," or 4-6-2 type, like the engine illustrated at the beginning of this chapter. On railways other than those I have mentioned it is the 4-6-0 type which is used for the fastest and heaviest express passenger trains.

Then, when we come to tank engines, we find a simply innumerable number of different kinds. For the short-distance suburban trains, 0-4-4, 2-4-2, 0-6-2 and 4-4-2 engines are all very popular,

Photo] [F. E. Mackay

CROMER EXPRESS, LONDON & NORTH EASTERN RAILWAY
4-4-0 ENGINE "PILOTING" 4-6-0 ENGINE

and there is an illustration of each one of these types on page 83. For longer-distance work, the 2-4-2 expands on the North Eastern to the 4-4-4, with a bogie at both ends of the engine ; and the 2-6-2 (known in America as the " Prairie " type), used so largely on the Great Western Railway, grows on the Brighton, and various sections of the L.M.S., to the vast 4-6-4, or " Baltic " type, some of the biggest examples of which weigh 100 tons in working trim.

Then there are various kinds of tank engine which spend their time in the humble work of shunting. Every railway has hundreds of the handy 0-6-0 type tanks ; and there are also diminutive 0-4-0 engines, on four wheels only, for some of the lighter work. Much of the heavier work of " sorting " trains in the big shunting yards, where long goods trains have to be pushed slowly over the " humps " described elsewhere, is undertaken by powerful tank locomotives of the 0-8-2, 2-8-0, 0-8-4 and 4-8-0 types, all, as you can see, with eight wheels coupled ; and there are also 4-6-2 and 2-6-4 tank engines on other railways for short-distance goods working.

Photo] [F. E. Mackay

CHELTENHAM EXPRESS, GREAT WESTERN RAILWAY
HAULED BY THE FAMOUS 4-6-2 ENGINE NO. 111, " THE GREAT BEAR "
This engine has now been converted to the 4-6-0 " Castle " type.